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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

OCTOBER 13-22.
Motor Exhibition at Olympia, London, W.

OCTOBER 21.
West of Scotland Iron and Steel Institute:—General meeting at Glasgow. Presidential address by John Craig, C.B.E.

OCTOBER 25.
Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "X-ray as Applied to Metallurgy," Paper by Thorne Baker, F.R.P.S.

OCTOBER 22-NOVEMBER 13.
Berlin Conference on Engineering Materials

Institute of British Foundrymen.

OCTOBER 25.
Sheffield and District Branch:—Ordinary meeting at Sheffield. "Diesel Engine Castings," Paper by A. J. Richman.

OCTOBER 29.
Lancashire Branch (Junior Section):—Visit to the works of Messrs. Sheepbridge Coal & Iron Company, Limited, Chesterfield.
Newcastle Branch:—Ordinary meeting at Newcastle. "Steel Foundry Practice," Paper by A. D. Kirby.

A Possible Way Out?

That the present state of things in the industry is not satisfactory needs no emphasis; but what does require emphasis is the fact that when affairs have reached their present condition it behoves all concerned to examine with the utmost attention anything which offers the slightest promise even of a partial solution.

We in the founding world therefore cannot afford to ignore the new movement for the rationalisation of industry which has recently gained so much attention in this country. It is a movement which has already received international support and authority, and which is sponsored by men of first-class practical ability and experience. In other words, it is no mere academic scheme for the reconstruction of industry. Indeed, it is not in the ordinary sense a scheme at all, but rather an attitude of mind. To rationalise industry we are asked not to adopt and put into practice any revolutionary scheme, any elaborate experimental reorganisation, but simply to acquire a distinctive—a rational—attitude of mind, and one which, we are told incidentally, is a matter of second nature to the bulk of the employers in the United States.

And what this attitude of mind stands for is the adoption of rational principles, in place of the slip-shod faith in rule-of-thumb and day-to-day working to which so many of us still cling. It stands further, for the fullest possible utilisation of all available resources—technical, human, statistical, scientific.

More than this, rationalisation is no more and no less than an extension to every part of the industrial sphere of a point of view which most of us already possess in some measure. It is the same standpoint that causes one man to select his men carefully, or train them to meet his particular needs; that causes another to pin his faith to some system of costing, and a third to instal a small laboratory or support scientific research.

How far is it reasonable to suppose that the adoption of such rational principles would solve our difficulties in the foundry? In the first place, the enthusiasts urge the benefits that accrue from large-scale combination and trustification—the elimination of cut-throat competition, satisfactory price-fixing, and the development of co-ordination throughout an industry. Secondly, as within the individual unit, they plead the cause of specialisation, of scientific research and its application, of consequent improved quality and better technical control. They advocate the widespread adoption of costing methods, with the invaluable resulting knowledge of true costs; the devotion of greater thought to purchasing, the extension of specifications, and the development of efficient selling technique.

These are but a few of the lines along which the new movement works, but they are characteristic. Can we in the foundry world say that such things leave us untouched? Can none of our problems be traced to just such troubles as the ones these methods would solve? Is our technical control all that it might be, our co-ordination effective, our scientific research sufficient to meet our needs? If the answer to all these questions is in the affirmative, then we can turn our backs on the rational view of industry as being only one more redundancy; but it might possibly be more to our ultimate benefit to welcome it with open arms and an open mind.

Mass Production.

The above caption does not refer to any engineering proposition, but to the output of foundry technical papers. We learn from a 20-page brochure, issued by the Institute of British Foundrymen, that more than one hundred technical papers are to be presented during the current session. We have on many occasions stated that there is at least one paper given on a foundry topic every day of the year, Sundays not excepted. The total output for Britain alone when the work of kindred societies is included cannot be far from 150, which leaves 265 for the rest of the world.

Apparently there are about 8 or 10 foundry associations in the United States, the principal of which, the American Foundrymen's Association, is usually responsible for an annual output of fifty papers. Yet undeniably there is a dearth of lecturers. Each year we have the same gentlemen often lecturing on the same subject. Surely out of the 2,000 members of the Institute there must be many who have much interesting knowledge to impart, but it cannot be expected that they will prepare a paper without being asked. We do not believe that a substantial money prize would help matters, as it cannot be said that there is a dearth of lecturers; it is only a scarcity of new lecturers of which we complain. Of the lecturers announced for this section certainly less than twenty are without previous experience as speakers, while a closer examination may reduce this figure to five. We attach absolutely no blame to the branch councils of the Institute, but insist that the fault lies with the foundry owners, who should allow and encourage a certain amount of simple investigational work to be carried out in their works. They would derive a dual benefit. Primarily, they would receive a maximum amount of benefit from the result of their research work, and, secondly, they would gain a certain amount of publicity of the best and most lasting type. Additionally, they would learn from this experience what was missing in order to finish their labours. In other words, they would learn what they required from the B.C.I.R.A., for at the present time the diversity of opinion as to the character of the work expected from this body is such that, whilst one founder expects a thesis on a run of his defective castings, another craves for data as to the specific heat of cast iron at high temperatures. Undoubtedly this mass production of papers will help to focus attention on the desirability of the prosecution of some piece of research work in every foundry—none is too small. The sole requisites are clear observation, and a few everyday measuring instruments.

Paris Foundry Conference Papers.

THE INFLUENCE OF CAST IRON AND SCRAP STEEL ADDITIONS ON THE QUALITY OF THE METAL IN BLAST FURNACE PRACTICE.

By J. L. Jones (Westinghouse Electric Manufacturing Company).

In this Paper Mr. Jones discussed the utilisation of the enormous amount of foundry scrap and scrap steel accumulated during the war. Its use, he pointed out, offered both advantages and disadvantages. After describing the classification adopted by the American Engineering Standards Committee for scrap treated in the blast furnace, he summarised the various effects of such additions upon the quality of the metal. The principal advantages of the additions were as follows:—(1) The consumption of coke was reduced (about 30 per cent.); (2) the production of metal was increased (about 60 per cent.); and (3) the blast furnace gases acquired a higher calorific power. On the other hand, the disadvantages arising from such scrap additions might be defined as follows: (1) Troubles due to special steel scrap; (2) troubles due to oxidation, and (3) lack of uniformity.

Certain lots of scrap were contaminated by the presence of material containing chromium, which, as is well known, is injurious to malleable cast iron. It was therefore desirable to separate such scrap from the rest. Too large an addition of highly oxidised scrap (the bars of burnt grates, for example) might produce a frothy and pasty metal, and this could be prevented only by using a higher percentage of coke and a ferro-manganese addition for purification purposes.

Lack of uniformity in composition and in the physical properties was, however, the principal disadvantage of these additions. The speaker gave an account of Brinell tests and chemical tests made to show this lack of uniformity. Hard spots were nearly always formed. Castings produced with the addition of scrap in the blast furnace showed a greater tendency to crack and presented difficulties in machining. A considerable number of American foundries therefore annealed their castings. In Mr. Jones's opinion, practical tests, accompanied by physical and chemical measurements, ought to be extensively carried out on castings obtained with the addition of scrap, so that a certain number of variable elements in blast furnace practice might be eliminated.

STUDY OF THE MACROSTRUCTURE OF METALS AND NON-FERROUS ALLOYS AND ITS APPLICATIONS IN FOUNDRY WORK.

By Professor A. Portevin.

In his Paper on this subject Professor Portevin remarked that while in the case of steel the macrostructural image and the micrographical image were different and of distinct origin, in that of non-ferrous commercial alloys there was no essential difference between the macrography and micrography. The attacking reagents revealed one and the same structure, a structure which was visible to the eye in the cast products.

After having described with extreme clearness the origin of the structure of solidification and the principal aspects of this structure (the formation of dendrites starting with crystallisation nuclei, developing in the form of conjoined grains or remaining enclosed in a eutectic), Professor Portevin considered the question of how these structures ought to be interpreted. Two principal characteristics had to be considered:—(1) The size of the grains or their number per unit of surface; (2) the form and disposition of these grains, which might be developed almost equally in every direction without any one disposition preponderating (structure with equiaxial grains or irregular structure), or, on the other hand, elongated in particular parallel directions (basaltic structure), or convergent (radial structure).

The elementary phenomena governing the genesis of structure were then examined by the speaker, who explained what was meant by the temperature curve and the rate of cooling, and how these two variables are influenced by what he termed the foundry factors. The principal factors which operated on crystallisation, and consequently on the structure of castings, were:—(1) The agitation of the liquid during crystallisation; (2) the speed of cooling and the temperature curve, and (3) the nature of the metal or the alloy.

The influence of each of these factors was examined. This examination led to various interesting applications, among others the ascertainment of the feeding zones for a casting; the determination of the running places and the points where chills have been placed.

The difficulties and defects of foundry work largely originated in the anisothermy of the castings in course of solidification or cooling. The macrostructure showed one of the results of this anisothermy in a visible form, and its study might therefore furnish useful and valuable indications.

A CURIOUS EXAMPLE OF THERMAL TREATMENT IN CAST IRON.

By Le Thomas and Domanski.

In this Paper it was stated that at the foundries of the Naval Dockyards at Indret the loam mould of a solid shaft having slightly given way under the pressure of the liquid metal a vacuum was formed in the casting which required a fresh supply of hot metal to fill it. The first metal had solidified normally while the second was slower in cooling. It then occurred to the authors of the Paper to examine the structures of both metals. Having been poured with a metal of very good quality the casting in question ought to have been pearlitic. The first metal, however, showed a structure very different from that which is known as pearlitic, while the second had a structure corresponding to the pearlitic type, but only in respect of its worst features, owing to the dimensions of the pearlitic lamellæ. The extreme slowness of cooling in the second metal had enabled the pearlitic constituents to collect in broad lamellæ below 700 deg. C.

On the other hand, the contact of the second metal having suddenly raised the temperature of the first, the latter had been subjected to graphitisation. Its structure, in fact, was that corresponding to the stable graphite-ferrite system.

The study of this incident showed that the properties of pearlitic cast iron are capable of being profoundly modified by thermal treatment following solidification.

THE HEREDITY OF CAST IRON.

By Andre Levi.

M. Levi observed that the question whether two metals of identical chemical composition can have different mechanical properties was still a matter of controversy. The tendency, however, was towards the affirmative. In his opinion, the fact that two metals showing identical analyses had different characteristics could only be explained by a difference in structure, and to explain this variation in structure it was necessary to ascribe hereditary qualities to metals, since variation in the speed of cooling cannot be considered in view of the fact that, while modifying the structure, it at the same time modifies the chemical analysis.

It was well known that the mechanical characteristics of a metal were primarily determined by the total volume, the size of the constituents and the distribution of the graphite. It was therefore the development of the graphite that required to be studied. He submitted the hypothesis that particles of graphite might in certain cases subsist during the melting of the iron in the cupola, such particles favouring the formation of thick flakes on cooling. Open grained iron (coarse flakes), the graphite of which had not had time to dissolve completely, retained for a long time the property of solidifying, producing coarse-grained castings; while in pig-iron, in which the graphite is finely divided—this graphite dissolving entirely during the process of melting—there would on cooling be no pre-existing particles, and the formation of the constituent graphite would be in the form of very thin lamellæ, even during several repeated heatings.

THE GRAPHITE EUTECTIC OF GREY CAST IRON.

By Professor Schutz.

Professor Schütz said that in order to obtain higher strengths in cast iron the necessity was recognised of making the separation of the graphite as fine as possible, and this had been accomplished as a result of the production of graphite eutectic. He explained the various theories that had been put forward regarding the processes of solidification and separation of the graphite. He described how the iron-carbon diagram had been constructed, gave a survey of the history of the theory of ferro-carbon alloys, and stated that science was tending increasingly to make use of the double diagram,* which was now employed by certain German foundries.

The speaker then examined the influence of graphite on the production of grey cast iron of superior quality, and particularly the artificial separation of the graphite in the finest form, viz. the eutectic form. Emmel, he said, had obtained good results in the cupola with sufficient overheating; while Klingenstein employed a combination of the reverberatory furnace and cupola, obtaining a total carbon content between 2.7 and 3 per cent. with a strength up to 21.5 tons per sq. in. Hitherto, however, it had been impossible to effect the separation of the graphite in eutectic form from the metal artificially. Experiments carried out by Professor Schütz in 1925 had led him to adopt a process in which metal with a silicon content of over 3 per cent. was cast in a chill. By this means it was found that this formation of graphite eutectic could be effected irrespective of the total carbon content.

Further researches on the influence of temperature, melting and overheating on the formation of graphite in cast iron, carried out by Klingenstein, Piwowarsky and Hannermann, had advanced the position of the question. It still required to be studied, however, for the purpose of obtaining cast iron the structure of which could be perfectly regulated like that of steel.

In the ensuing discussion Professor Portevin said that other researches on the persistence of graphite in cast iron had been carried out, but which had not been mentioned by Professor Schütz, and that, on the other hand, some of the hypotheses formulated by him had been known for some considerable time. He thought it undesirable that so many hypotheses should be superimposed, and that it was best to adhere to a single conception. Emphasising the fact that in the lecturer's process the decomposition of the mixed crystals took place without gradual cooling, he asked what was the process of decomposition in these mixed crystals.

Professor Schutz then stated that the germinative power of the primary crystals exercised a great influence on the formation of graphite eutectic.

Professor Portevin asked: "What temperature should be maintained in the liquid state in order to obtain a metal composed of graphite eutectic and ferrite?" "What is the time and rate of cooling?" "What silicon and manganese contents are recommended?"

In his reply, Professor Schutz stated that such a metal could be obtained in the cupola at 1,300 deg. C., with 3 per cent. of silicon and 0.02 to 0.09 per cent. of manganese. With regard to the cooling, this was very rapid, as the metal was cast in a chill.

SOME PROPERTIES OF SPECIAL NICKEL-MANGANESE BRASSES.

By Le Thomas.

In this Paper M. Le Thomas gave an account of the supplementary researches carried out by him on the special brasses containing considerable proportions of nickel and manganese, viz., 5 and 3 per cent. respectively, reputed standard 59-41, submitted by him to the Liège Congress in 1925.

In studying the mechanical characteristics of these brasses at high temperatures M. Le Thomas came to the conclusion that the breaking and elongation load varied relatively little with the temperature. On the other hand, the Brinell hard-

* The recent researches of Professor Hanson definitely indicate the reverse.—Editor.

ness diminished sharply when the temperature rose. The shrinkage of this alloy might be estimated at 11.3 mm. per metre. It showed no change dilatometrically, which was a great advantage. Its melting point, measured with a recording pyrometer, was found to be 885 deg. C. These brasses did not appear to require hardening. Their resistance to corrosion was very great compared with other alloys.

ELECTRIC MELTING OF COPPER ALLOYS.

By R. Lemoine.

The two types of furnace which appeared most suitable for melting copper alloys were, according to M. Lemoine, rotary-arc furnaces or furnaces with revolving arc and low-frequency induction furnaces. In the special case of foundry work these furnaces had disadvantages: the production of alloys rich in copper or rich in lead, the necessity of "by-passing" the furnaces when production is intermittent, and of first casting a certain quantity of metal when the alloy produced by one furnace is changed in the course of the day. In regard to whether the electric furnace was commercially advantageous in the casting of copper alloys M. Lemoine thought it would be a mistake to refuse *a priori* to examine the possibilities of such a furnace within certain limits.

THE USE OF THE ELECTRIC FURNACE IN IRON FOUNDRIES (The Duplex Process).

Paper by R. Lemoine, Read by M. Vanzetti.

As electric power is generally expensive, it was desirable to reduce as far as possible the time during which it was used. If melting was begun in the cupola and afterwards completed in the electric furnace with the addition of a good ore, 30 per cent. of the current consumption could be saved. Experiments on this subject had been made at the Milan Steel Foundry Company, with a small cupola and two electric furnaces. The employment of two electric furnaces working alternately enabled the current to be used uniformly. It was necessary, however, to consider the wear of the roof of the furnace and the electrodes owing to the ore additions, which were regarded as dangerous by certain practical men. M. Vanzetti said that he regarded this method as being economical, and intended to carry out further systematic experiments at an early date.

TESTING AND PROPERTIES OF FOUNDRY SAND.

By Prof. Sirovitch (Rome School of Engineering).

The author of this Paper stated that by testing foundry sands not only could the characteristics of the varieties available be accurately known, but the properties which the best sand should possess could also be determined. These properties being known, it might be asked whether it was possible to produce synthetically a sand possessing them. Technically the problem presented no difficulty. The author explained how it might be solved. From the economic point of view it was possible to conceive contrivances capable of lowering the cost of production, for example, the reclamation of the sand of cores prepared with green sand and binding material with a basis of drying oil. He held that the factors affecting the properties of a synthetically-prepared foundry sand were within our control, and that it was possible to modify them as might be wished.

TESTING CAST IRON.

Two interesting Papers were read on this question, one by M. Girardet, entitled "A Simple and Rapid Method of Determining the Mechanical Properties of the Structure of Cast-iron Castings," and the other by M. P. Herman and Mdlle. H. Henquin on "Some Testing Methods and the Properties of Various Grey Cast Irons," the latter being submitted by M. Carlier.

M. Girardet recommended the shearing test with the Frémont machine, but by measuring to 1/100 mm. two rectangular diameters of the polished test piece, for the sole purpose of obtaining a corrected surface with which the shearing strength could be related. He then determined the Δ of the hardness test on the sheared section itself by means of a small special machine developing a pressure of only 75 kg. on a ball 1.59 mm. in diameter.

In the Paper by P. Herman and H. Henquin it was stated that in the hardness tests (10/3000) the authors found that the edges of the indentation were split beneath the load. This statement was questioned by M. le Thomas. They recommended shearing by the drift test as a substitute for the ordinary shearing test. This method of drift shearing was the subject of a lively discussion. In the first place, as M. le Thomas observed, parasitic strengths were much greater than in the case of ordinary shearing. The punching was always conical notwithstanding all precautions taken. Finally, the drift test enabled only one test with the test piece to be made, whereas it was desirable that the tests should be repeated in order to ensure that the results were average.

With regard to the correlation between the mechanical properties and the constitution of grey cast iron, M. le Thomas expressed agreement with the authors of the Paper in so far as he recognised that the thermal treatment of cast iron was of no interest as a process for improving the physical and chemical properties, but merely as a stabilisation process for softening the metal by increasing the graphitisation.

I.B.F. Elects New Members.

At a meeting of the Council of the Institute of British Foundrymen, held at York last Saturday, the following were elected :—

As a Subscribing Firm.

Bureau of Information on Nickel, Limited, 2, Metal Exchange Buildings, Leadenhall Avenue, E.C.

As Members.

H. H. Bliss (engineer and manager, Westgate Foundries, Town Dock, Newport, Mon.); G. L. Cassidy, A.C.G.I., Stud. I.C.E., Grad. I.M.E. (superintendent of test foundry, Morgan Crucible Company, Limited, Battersea Works, Battersea, S.E.9); J. K. N. Davis (engineer and ironfounder, Davis Gas Stove Company, Limited, Luton); S. B. Horsman (foundry assistant manager, Mitcham Foundry and Ironworks, Eveline Road, Mitcham, Surrey); W. E. Horsman (ironfounder and sanitary engineer, Mitcham Foundry and Ironwork, Eveline Road, Mitcham, Surrey); S. Ingrams (S. Ingrams & Company, 283, Finsbury Pavement House, E.C.2); W. Y. Pateman (foundry manager, Luton Aluminium Castings Co., South Road, Luton); E. W. Sutton (foundry foreman, J. Stones & Company, Limited, Deptford); S. J. Tomkins (foundry consultant, Denbigh Engineering Company, Tipton Staffs); Commander E. C. Withers (general-manager, Southern Foundries, Limited, Waddon, Croydon); C. H. Kain (foundry manager Lake & Elliott, Limited, Braintree); A. Edwards (director, Harrison Bros., Atlas Foundry, Commercial Street, Middlesbrough); E. H. Griffin (foundry secretary, Fine Castings, Limited, Forest Road, Fishponds, Bristol); I. Rees (foundry manager, Fine Castings, Limited, Forest Road, Fishponds, Bristol); C. W. Coleman (foundry engineer, 10, Savoy Street, Strand, London, W.C.2).

Dr. T. Geilenkirchen (Director, German Foundry Owners' Federation, Düsseldorf, Breitestr. 29); R. A. Jones (ironfounder, W. & J. F. Jones, Limited, Pendlebury, Manchester); M. Langenohl (chief engineer, United Steel Works at Gelsenkirchen, Schalker Verein, Gelsenkirchen); G. Moran (manager, Reliance Foundry Company, King's Hill, Wednesbury); Dr. S. G. Werner (foundry owner and President-General, German Foundry Owners' Federation, Düsseldorf, Industriehaus, Wehrhahn). J. W. Blair (foundry foreman, Adams Hydraulics, York); H. Sayers (foundry manager, Hill Bros., Goodman Street, Hunslet); A. S. Worcester (foundry manager, Moorbottom Ironworks, Huddersfield).

As Associate Members.

N. C. Ashton (iron and steel representative, Heap & Partners, Limited, 9, Albert Square, Manchester); T. Gibson (foreman moulder, S. S. Stott & Company, engineers and elevator manufacturers, Haslingden); H. Holdsworth (moulder); H. A. Rishton (works manager, S. S. Stott & Company, Laneside Foundry, Haslingden, Rossendale); L. Turner (moulder); W. Blackadder (draughtsman, Falkirk Iron Company, Falkirk); W. W. Blair (works chemist, R. & A. Main, Limited); C. Gillespie (assistant foreman moulder, Shanks & Company, Limited, Barrhead); F. H. R. Butters (draughtsman, Macfarlane Strang Company, Limited, Lochburn Ironworks); H. Chambers (moulder, Primrose & Company, Jane Street, Leith); W. K. Meldrum (foundry progress superintendent, Cammell, Laird & Co., Cyclops Works, Sheffield); J. Henderson (foreman moulder, Coltness Ironworks, Newmains, Lanarkshire); G. Lumsden (brass moulder, Hunt, Nelson & Company, Limited, Motherwell); D. C. McPhie (foreman moulder, Argus Foundry, Thornliebank); R. McIntyre (foreman moulder, Burnbank Foundry, Falkirk); T. Murray (assistant foreman, Glenfield, Kennedy, Limited, Kilmarnock); B. D. Smith (pattern-maker, Beardman's, Limited, Parkhead); T. Tyrie (metallurgist, Glenfield & Kennedy, Limited, Kilmarnock); C. S. Whitfield (foreman moulder, Cochrane & Company, Middlesbrough), N. E. Robson (works chemist, Lake & Eliot, Limited, Chapel Hill, Braintree) W. Taylor (foundry engineer, James Evans & Company, Limited, Britannia Works, Manchester); L. J. Tichelly (assistant manager, Foundry Supplies, 97, Queen Victoria Street, London, E.C.4); J. Wilson (foreman moulder, North British Rubber Company, Edinburgh).

As Associates.

W. Jardine (book-keeper and cashier, worked in foundry for last 23 years, Sharp & Company, Rennox Foundry, Alexandria); A. Reid (foundry clerk, Fullwood Foundry Company, Limited, Hamilton); D. Rose (moulder, J. & D. Tullis, Clydebank).

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for August, state that the number of furnaces in blast at the end of August was 165, a decrease of 9 from the previous month. Production, both of pig-iron and steel, in August showed a decline as compared with July; pig-iron from 645,800 tons to 596,100 tons, and steel from 687,100 tons to 643,100 tons.

Returns received from 134 firms employing 89,360 workpeople show that employment during August improved, an increase of 3,483 being recorded. The average weekly earnings in July of 112,860 workpeople employed by 123 firms amounted to £3 1s. 6d. compared with £3 2s. in June, the decrease being partly due to the holidays in Scotland.

Publication Received.

Demag News.—The second issue of this publication fully maintains the high standard of the first number. The principal article is devoted to Cranes for Harbour Construction, but foundrymen will find the "Gasification of Coke" and "Small Bundling Presses for Sheet Metal Scrap" of more interest. It is a 48-page publication entirely devoted to technical matter.

Foundry Query.

Moulding Powder.

The Federation of British Industries have received an inquiry for the manufacture of Apollo Moulding Powder, which we take to be parting powder. Information should be sent to the Editor of this Journal.

Mechanical Engineers Elect Foundryman as President.—The American Society of Mechanical Engineers for their Erie, Pa., section has elected Mr. M. S. Reed, of the Erie Foundry Company, as chairman for the ensuing session.

Foundry Costing.

There was an encouraging attendance at the opening meeting of the new session of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, held at the Engineers' Club, Waterloo St., Birmingham, last Thursday. Mr. F. G. Starr (Branch President) was in the chair and a discussion on "Foundry Costing" was opened by Mr. S. Ashton Hill, of West Bromwich.

Mr. Hill said the first necessity was to arrive at some basis of costing. The fact that in the ironfoundry it was a basis of weight was most unfortunate, because people got the impression that castings were worth so much per cwt. whereas a proportion of the value should be taken on a wages-cost basis. There were, of course, innumerable methods of costing, some of them grossly inaccurate; but among them there were no doubt quite a number that would give a commercially practicable result. By that he meant that they did not want to quibble over small points, for they could not expect costing to be an exact science. At the same time that was no reason why they should not reach a sufficiently close approximation for their purpose. Whatever scheme they adopted, and however much they subdivided their figures, there was still plenty of margin for people to suggest that certain items ought to go into some other compartment. Even so, they would find that within certain limits the final result as to cost was not materially affected. Any system of costing had to be adapted to the particular class of work carried on by the foundry, whether it was a jobbing foundry or a foundry laid out for high-class repetition work. They must have a clear idea in their mind of the various items of expenditure in the making of a casting, such as iron, coke, labour on the cupola, gannister, limestone, electricity or other power, sand, coal dust, plumbago and a hundred other things. Additionally there were all the incidental expenses called overhead charges. When they had a list in front of them of all the contributory costs the next thing was to decide how to apportion those costs in the case of an individual casting. The best way was to begin with the molten iron and arrive at its cost. That meant taking account of the cost of iron, loss on melting, cost of coke and subsidiary items and labour incidental. After that they had to consider the making of the casting and the cost of the materials used in the foundry. They must include not only productive wages, but unproductive wages, such as labouring, dressing, supervision and any labour in the foundry not actually used in the skilled making of the castings. He had come to the conclusion that much the fairest way of putting on foundry costs was as a percentage on wages, so that the higher the wages the greater share they had to bear of the internal foundry costs. Overhead expenses should be put on as a percentage on total prime cost. Another item was the outward carriage. Finally, there was the question of net profit and that, of course, was the difficulty to-day. A difficult question was how to treat defective castings. In his view the best practice was to adopt the basis of the actual castings invoiced. Any wasters in the foundry were taken as a sort of foundry expense and were not shown in the book, because the cost of keeping a record of wasters in the foundry would be prohibitive in most cases.

Costing and Price Cutting.

Mr. F. J. Cook said that if they took the ordinary routine kind of foundry, such as a motor works making three models, with a known output of each per week, it was quite feasible to imagine that a reasonable costing system could be got out for every item of manufacture, and he knew that in most foundries connected with this class of work they had a very close approximation of the cost of each article. When, however, they were dealing with a jobbing foundry, where there were no two jobs alike and where the output was constantly changing, both as to the weight and the time taken to manufacture the article, the matter became more difficult. It was regrettable that when a man had arrived at a price which was fair to himself and to the buyer he had to meet all sorts of silly quoting by jobbing founders who were the prey of buyers who told them all sorts of tales and generally induced them to quote a very low price. If it were only possible to persuade the ordinary jobbing founder to quote a price that was reasonable from his point of view and also from the point of view of the purchaser, there would be fewer foundrymen filing their petitions in bankruptcy.

Castings Plus Runners as Basis.

Mr. H. J. Roe thought there was a very urgent need for the adoption of some uniform costing system in the foundry industry. It was not perhaps possible to evolve a costing system which would apply to every foundry, but if they could arrive at some basis of foundry costing it would be of great assistance to the trade. Mr. Roe called attention to a book published by a well-known American foundry accountant in which the interesting point was discussed of the relation of the weight of the casting to the weight of the gates and risers for that casting. For example, if they were making a plate casting the weight of the gates and risers, if necessary, in proportion to the casting, was comparatively small. On the other hand, if the casting were in the form of a frame ½ in. thick all round, the gates and risers would probably be heavier than the casting itself. That was a point which required a great deal of consideration—namely the amount of molten metal needed to produce the casting. He thought most foundries took the final weight of the product instead of taking the cost of the amount of molten metal required to produce the casting. As to the distribution of overhead charges, there were several methods that could be applied. One basis was the time occupied by the moulder in producing his mould. Another was the weight basis, and in the case of machine moulding it could, of course, be worked out on the production capacity. These three processes all gave different results and the question was which was the correct one to adopt. It was this consideration which led him to emphasise that if some uniform system were adopted it would be of great advantage to the trade. A matter to be considered in charging overheads was the amount of floor space occupied by each man in producing castings. Mr. Roe added that it was very interesting to ascertain the number of good castings produced as against the number of moulds put down by each individual man.

Mr. A. Harley said that in dealing with production costs his firm took a time basis, after which a percentage was added to allow the worker to make something on it. In order to record that information every man had to clock on the job and clock off. The clock cards were the documents from which they compiled their costs on the job in regard to production wages. On the card was a record of how many good castings the man had made and how many bad ones, as well as the time taken, and on that card the man was paid. He did not like costing by weight.

Mr. W. J. Flavell said the estimating of pattern costs was one of the most difficult problems in the foundry trade and Mr. F. C. Edwards thought that if the discussion emphasised the need for more serious attention being devoted to costing systems it would not have been wasted. Mr. Edwards added that prices should be such as to give the people earning their daily bread in the foundry business some butter on it.

Mr. D. H. Wood, in proposing a vote of thanks to Mr. Hill for introducing the subject, commented upon the encouraging attendance which he hoped would be maintained throughout the session.

Mr. T. H. Turner, in seconding, said the whole point of costing systems was to arrive at a price which would assure fair dealing as between the producer and the consumer.

The vote of thanks was heartily accorded.

Enamels for Hardware.—The American Bureau of Standards is seeking for a wider range of enamels for use with sheet iron and steel, as the types available are too limited. They have paid special attention to the effect of mechanical impact and sudden temperature variation, and favourably reported on the incorporation of flint and sodium oxide.

Catalogue Received.

Core-Sand Mixer.—The Fordath Engineering Company, Limited, of Hamblet Works, West Bromwich, who are so well known as suppliers of "Glyso" core oils, have been appointed sole selling agents for the "Rotoil" oil and sand mixing machine. Mixing is effected by a system of fixed and moving blades mounted in a circular pan. The machine illustrated in the 12-page booklet received by us has a capacity of between 3 and 4 cwts., and requires a 6-h.p. motor for its actuation. Mixing is accomplished in two to four minutes, whilst half to three-quarters of a minute is required for discharging. The machine weighs 26 cwts., and occupies 6 ft. by 4 ft. 6 in. of floor space. The base of the mixer is a substantial circular pedestal casting, which carries all bearings and totally encloses the worm transmission gearing. This construction permits of the main bearings and transmission gear to be entirely submerged in oil—a desirable feature when working in the presence of fine sand. Mounted on this pedestal is a machined cast-iron plate, to which is bolted a heavy steel flanged ring, forming the walls of the pan. Mounted equidistantly in the upper part of the pan are three fixed blades, and in the centre is a rotating hub carrying the moving blades, of special design, which sweep under the fixed ones. The rotating blades are readily renewable without taking down any part of the machine other than the domed cover forming the upper part of the hub. All parts of the pan and blades are designed with smooth sloping surfaces, avoiding any projections or horizontal faces, which have the objectionable habit of collecting and confining aggregations of sand. This ensures that neither untreated sand nor oil can fall into the mix on discharge. The discharge is automatic from a shoot, and is so arranged that standard barrows may be filled. The catalogue dealing with this machine is now ready for distribution to the foundry industry on application.

The Middlesbrough Branch Programme.

In our issue of October 6, on page 18, it was stated that the President of the Middlesbrough Branch, Mr. F. P. Wilson, has credited Mr. A. W. Bagshawe with giving us a Paper on "Costing." This is a mistake, as Mr. Bagshawe is due to give a Paper before the branch on "Foundry Design and Handling." Actually Mr. D. G. Pennington is to treat of the subject of costing on January 21.

Japanese Pig-iron.—Discussing the proposed increase in the import duty on pig-iron, the Japanese Minister of Finance recently stated that it was necessary for Japan to develop her iron and steel industry. Consequently the authorities had been assisting by means of subsidies. They were now considering how best they might continue to help. The Minister, however, denied that the authorities had any intention of establishing a prohibitive duty on Indian pig-iron, as this was undesirable both for the consumer and the development of the Japanese steel industry itself

The Industrial Engineer.—Before a recent meeting of the Institution of Engineers and Shipbuilders in Scotland, Mr. Alfred J. T. Taylor read a Paper on "The Industrial Engineer," stating in the course of his remarks that the necessity for an industrial engineer, who must be a great deal more than a boiler-room foreman, had not been generally recognised. So there were numerous cases of industrial works whose output was seriously limited by their steam plants, which often maintained a so-called efficiency in the boiler-house at the expense of production, and which frequently bought power when they should produce it themselves as a by-product of their steam requirements. Out of nearly 2,000 studies of industrial plants made in this and other countries by the author and his associates, over 70 per cent. had shown that the boiler-room had been a limiting factor in production, and that some processes had suffered, or had been delayed, through an inadequate steam supply or through fluctuating pressures. Those investigations further showed that over one-half of the plants should and could supply their own power for considerably less than they could possibly purchase it.

Works Economics.

Melting and Other Costs Examined.

In his Presidential Address to the London Section of the Institute of Metals, held last Thursday, Mr. A. H. Mundey dealt with the subject of "Works Economics" from the point of view of the metallurgist. Dealing first with fuel, he said that in small foundries, at any rate, solid fuel in the form of coke was almost always used, and he believed it was economical to use it, using the term in the broadest sense. In small foundries, where the fireman had reasonable opportunities, in between looking after his heats, to clean his furnaces and to look after the fuel supply, it was as economical to use coke as any other fuel. There might be various other aspects of the matter, but from the fuel point of view it was as economical to use coke as anything else when working on a small scale. Capital outlay was minimised, and therefore overhead expenses were kept down, and the operations were simply and cheaply performed. The drawbacks to the use of solid fuel were manifold; there was the carting of the solid fuel, the removal of ashes, the fact that only a certain proportion of the fuel was burned, there was smoke, dirt, space occupied and a number of other factors to be set against the economy of the use of solid fuel as fuel, yet he knew plenty of foundrymen who, if starting a foundry of four or five pots, and not having too much money, would put in pit fires using coke as fuel. Mixtures of coal and coke were often used with advantage in reverberatory furnaces. Cupolas and blast furnaces must in almost all cases—although there were exceptions—be worked on solid fuel. An easy and readily available alternative to solid fuel was town gas, but for ordinary purposes town gas seemed to be very expensive.

Town Gas.

At the same time there were cases in which it was used to advantage, in spite of its high cost. Nevertheless, town gas was undoubtedly costly. In one of his own company's works it was necessary to decide a short time ago whether a section should be started up using town gas, coke or something else. It was not desired to spend too much money; a certain amount was available, but coke was ruled out as being an intolerable nuisance. The labour, space and dirt involved outweighed any small advantage in the matter of cost. It was decided, therefore, to adopt gas at first, but when the costs came to be analysed it was found that the job could not be made to pay with the high cost of gas. The article to be made was so closely priced that the cost of gas made it impossible to produce at a profit, and oil burners were introduced, which enabled a small profit to be made. That was an absolute case which was worked out right down to the bone, various types of apparatus being installed to ascertain how the costs came out in each case. That was not in London. On the other hand, his friend, Mr. Dean Chandler, chief physicist to the South Metropolitan Gas Company, who had helped him very much, had given him some figures showing that in the case of one company in London, melting 250,000 lbs. of general yellow metal—brass, copper and gunmetal, principally gunmetal—they were able to make a considerable saving by the use of town gas. In his own works, when dealing with low-melting point metals—white metals generally—it had been found that town gas paid thoroughly well. In that particular case there was no available space whatever for handling solid fuel. The cost for melting and re-melting these alloys came out at between 3s. 6d. and 4s. per ton, and the gas bills were appallingly high, but the engineers and the physicists of the South Metropolitan Gas Company—he was not advertising the gas company, but he must speak well of the people who had helped him—had given such an enormous amount of assistance that the work was being carried out very satisfactorily from all points of view. It paid in this case to use gas, because of the convenience and the cleanliness and the clever way that the workmen and the overseers did their work.

Producer Gas.

Producer gas, when working on the regenerative principle, and also Mond gas was used, and at Woolwich there were a large number of pit fires working with producer gas. Many people were apt to think this apparatus worked automatically, but very careful supervision was required. At one time he used to send out every morning and have an analysis made of the producer gas, and it was found possible to say, from the composition of the gas, which man had been in charge of the producers. They always tell when one particular man had been in charge because the gas always contained 1 or 2 per cent. more of CO. It had never been found how the man did it, but it was the fact, and that man was worth a good deal more than others.

Tilting Furnaces.

For general foundry work he had been told by a number of men who had had considerable experience, that one-third of a ton of coke per ton of metal was a general requirement. For tilting furnaces a very much smaller amount of coke was used. From 60 to 100 lbs. of coke would melt 500 lbs. of gunmetal in the tilting furnace, using a 600-lb. pot, the life of the pot being about 40 heats.

With regard to the figures which had been handed to him by the South Metropolitan Gas Company, as to the costs of using gas and coke, these showed that for 250,000 lbs. of yellow metal using coke the total melting costs, including labour and a number of small contingent expenses, the figure was £613 10s., whereas with gas the cost was only £420 6s. 2d. When he looked into these figures closely he found that a good deal more coke was being used than was the general custom, and there was no doubt that the gas figures took advantage of every possible factor in favour of gas—not improperly, of course—and the final result was certainly in favour of gas. On the question of comfort, convenience, facility of working, etc., the advantages of gas were immeasurable.

Electric Furnace Costs.

In one very large works—the name of which he could not give—the Ajax-Wyatt type of electric furnace was used with very gratifying results. Making 70/30 brass, and melting 180 tons, in four weeks, there was a total saving in favour of the electric furnace of £507. There was also a saving of £250 in the size of the deadheads, and a further considerable saving in crucibles. Electricity was at 1d. per unit. He had had an opportunity of looking at these accounts in confidence, and every conceivable item had been taken into consideration. In a Paper before the Institute of Metals, in March, Mr. Campbell had given the following figures. Melting one ton of 60/40 brass, 220 kw.-hours at ¾d., 14s.; lining and repairs, 1s. 6d.; labour, 8s. 4d., or a total of 23s. 10d. Mr. Campbell also claimed a saving of 10s. in metal losses. For pit fires using coke—the average of the Birmingham district—and dealing with the same class of material, the following figures were given by Mr. Campbell:—Coke, 8s.; crucibles, 4s. 6d.; repairs, 1s.; labour, 22s. 6d. or 36s., against 23s. 10d.

The next item in importance to fuel was the metals used. It was the duty of the metallurgist to co-operate with the other departments to ensure a suitable supply of ingot metal, castings, bars, sheets, etc., and efficiency in this connection really amounted to common sense, and not something which could be put on paper as showing a gain when it really was not a gain at all. If this common sense were not exercised there was the risk of cumulative effects from small losses which could not be detected until the work had proceeded a long way, and then it might be found that an apparently profitable cost was really a loss. On the other hand, a too elaborate arrangement of apparatus and expensive machinery might result in such enormous overheads that again a loss would be involved instead of a profit. Therefore, it was only by careful and accurate records of the results at all stages of a process that the desirable results could be obtained. The metallurgist must know at all times exactly where to tighten up things and where to slacken off a little, and it was for this reason that he had referred to efficiency in the matter of materials and their handling as common sense.

Reclamation of Metals.

As an instance of the manner in which it paid to go to considerable expense in adopting a process, Mr. Mundey said that Mr. Harris had invented a process for softening and removing tin and antimony and arsenic from lead. The molten metal was passed in a finely divided stream through a cartridge which was charged with a reagent, consisting of the hydrates of sodium and calcium. The tin was converted into calcium stannate and the antimony into antimonate, the lead being left intact. The lead was finally delivered in a softened condition, whilst the other materials were won back from the compounds which had been formed. This was an expensive process; the royalties were considerable, and the cost of the apparatus was high, but it was highly successful. At the same time it would not be possible to carry out the process on a small scale, because it required many thousands of pounds to finance it. The interesting thing was that Mr. Harris worked with an old-fashioned Siemens gas-producer and a reverberatory furnace, and it worked splendidly, and this all demonstrated what could be done when operations were placed in charge of a practical metallurgical engineer. Such operations as these, however, could not be made successful unless extensive laboratory experiments were first carried out, followed by full scale works experiments, before attempting to put them into commercial use. There was no short way out, and it must also not be overlooked that the costs thus incurred had to be paid for ultimately by the purchaser of the goods produced. Frequently an apparently profitable process showed up some weakness and then more experiments had to be carried out, making the final result a loss.

Overhead Costs.

One of the biggest worries of the factory manager was the question of overheads, and he often felt that he was over-burdened in an unjust manner. Generally speaking, however, that view was wrong. Overhead expenses were absolutely necessary, although they were often regarded in the same way that people regarded income tax. The foundryman generally looked at the question of costs from the point of view of the cost per lb., and did not go into elaborate calculations in order to take into account every factor. At the same time, it was astonishing how near to the actual cost the foundry manager, working on the less scientific basis, often was. Mr. Mundey mentioned a case in which he was asked at the recent Engineering Exhibition at Olympia for a price for certain castings. Not being a commercial man he asked one of the assistants, and he immediately replied 1s. 3d. per lb. When this figure was investigated, after the order had been placed by the inquirer, it was found that it just gave a reasonable profit. By comparison with this, a case was mentioned of one of the most elaborate systems of account keeping he knew, which showed the cost for similar articles to be 2s. per lb. This was in one of the largest foundries in the world, and the comparison was made in an endeavour to show that a comparatively small works, with less elaboration as to machinery and accounting methods, can often turn out products at a lower price than a large works. This was because of the very high overheads as compared with the smaller foundry.

Speaking on the question of costs generally, Mr. Mundey said he had consulted some people of very high standing in the trade and had obtained figures of costs applying to various classes of work which he thought would be interesting. All these figures are works costs before contracts for delivery of the finished article were entered into, and they were given as indicating the position in these particular circumstances.

Manganese-Bronze Casting. 8 Tons.

Works Costs.

Metal per ton	£70
Melting	5
Pattern making	4
Mould and core making ...	10
Fettling and pressing ...	9
Total per ton	£98

In this case the figures were round figures and, therefore, approximate, but they related to an absolutely first-class job of the highest grade. The actual job was a propeller. The cost of fettling appeared to include some work not usually included, and the overheads were not stated separately, but were absorbed in the general figures.

The following figures are those relating to another large firm and refer to a most important casting.

Manganese-Bronze Castings.

Weight of Casting 12 cwt.

	£ s. d.	£ s. d.
Metal per lb. ...	6¾	
Stores and sundries	2	
Loss	½	
	9¼	
Weight × 9¼d. ...		52 11 9
Wages	5 1 4	
Core making ...	1 11 8	
Fettling	1 2 8	8 19 0
Cost, each casting,		£61 10 9

Cost per ton of metal £102

The next figures quoted related to phosphor bronze for bushes in batches of 25 tons.

	£ s. d.	
Wages at 1.5d. per kilo	6 7 0	per ton
Fuel, stores, etc. ...	4 0 0	
Metal without loss ...	98 0 0	
	£108 7 0	

Coke at 36s. per ton.

These figures are for material which would be sold at 1s. 3d. to 1s. 4d. per lb.

The final set of figures quoted related to the production of brass strip; electrolytic copper and zinc. The virgin metal is charged at market prices, whilst the cuttings from the strip or previous rollings were charged at a lower price. This was a very large works, and Mr. Mundey said he had never come across a firm which showed greater courage in the arrangement of its costs. Deadheads and scrap were included at the same value. As part of the fuel, ashes from the ash pit were washed and used and were credited to the costings at a very low rate.

Brass Strip, 70:30.

Electrolytic copper, £65 per ton.
Zinc, £35 per ton.
Selected scrap cuttings, £52 10s. per ton.
Deadheads credited at scrap value.
Ashes and spillings credited at valuation.
Fuel, coke at 37s. 6d. per ton.
Crucibles, £3 10s.
Cost per ton of metal, 13s. 5d.
Wages, per ton, 15s. 9d.
Overhead charges 600 per cent. on wages.
Total cost of castings, £63 per ton.

Experience had shown, said Mr. Mundey, that very often the more organised works has a higher overhead and a lower actual wage than a smaller works on any particular article, though the individual earnings were generally as high. The output, however, was greater.

In another case the value of the metal was given as £72 per ton, allowing for scrap, the wages were £6 and the overheads £17, or 230 per cent. on wages. In the ordinary way, continued Mr. Mundey, a figure of from 100 to 150 per cent. was estimated for overheads, and that was about right in ordinary circumstances, but in cases where expensive machinery was employed there might have to be a very much greater percentage added in respect of overheads. One case specially mentioned was that of a works where there is a large forging press. The overhead charges in respect of that forging press amounted to 10ls. per hour, whereas the wages were, one man at 2s. per hour and eight men at 1s. 6d. per hour, a total of 14s. per hour, yet the actual interest on the capital and the cost of upkeep in respect of the machine was 10ls. per hour. The difference in overheads according to the nature of the shop was also emphasised by Mr. Mundey when he mentioned a case in which a certain heat-treatment operation was transferred from one shop to another owing to difficulty of carrying out the work, due to size, in the shop usually engaged upon this work. The operation was the heat treatment of an axle. When the costs were analysed for the second shop it was found that the overheads cost more than the material. It would thus be seen, he continued, how overheads could kill a job, and it was necessary to watch this point very carefully.

Labour.

The last but not least important factor in works economics was labour. In comparison with some classes of engineering shops foundries were not always attractive places. The work was generally very dirty and the place very hot, and at times the work was distinctly unpleasant. Nevertheless, in many cases it was very interesting, and demanded an intelligence and skill which did not always secure the recognition and appreciation it deserved. Mr. Mundey gave a brief outline of the various methods of payment adopted, viz., time work, piece work and systems based on bonus. Pointing out that some trade unions insist upon time work only, Mr. Mundey paid a tribute to the helpfulness of the ordinary trade union official if he were approached in the right way, and he reminded his audience that it should appreciate that the trade unions are as esteemed by the skilled workers as the Institute of Metals or the Institution of Civil Engineers or the Institute of Chemistry are by their members. We should not "sniff" at trade unionism. The very best system of payment, strictly speaking, was individual piece work, but it was often a nuisance. Finally, Mr. Mundey stressed the point that first-class workmanship is one of the finest assets any business can have, and for this reason alone he urged all engaged in commercial operations to cultivate a spirit of goodwill throughout the work so that the workmen would be encouraged to give of their best. From this point of view he welcomed the schemes that had in some cases been put into force, and were being spoken of in others, at the moment for giving the workmen a financial interest in the firms with whom they are employed. Incidentally, stress was laid upon the need for the closest co-operation between the metallurgist and the buying and selling ends of a business in order, on the one hand, to prevent the buying department from purchasing material unsuitable for the works, and, on the other hand, to prevent the sales department accepting orders so hedged round with specifications that it is practically impossible for the works manager to fulfil them.

A hearty vote of thanks was accorded Mr. Mundey at the conclusion of his address.

Scrap in the Non-Ferrous Foundry.

The Handling Problem.

By "Onlooker."

While falling prices of iron and steel have made ferrous scrap something like a drug in the market, the scarcity of best select brands of copper has given a marked incentive to the demand for old material, while a temporary shortage of best spelter has compelled manufacturers to be on the *qui vive* for parcels of first-class brass scrap. On a market of falling values for virgin metals, the quotations for scrap have given way unwillingly, for here also supplies of a reliable nature are far from plentiful.

One result of the narrowing of the margin between scrap and virgin metals has been to compel foundry owners to consider—not for the first time in their lives!—whether the saving in purchasing old material is actually as substantial as it appears to be on paper. It is, of course, possible to calculate the value of cartridge metal turnings or gunmetal borings in terms of the virgin metals from which it is made, and over and above the ascertained worth to impose an allowance for loss from dirt and impurities, arriving at a figure which, on the face of it, shows a respectable margin, but how much of that margin remains by the time the material has passed through the metal warehouse, inspection department and heat-weighing shed, to arrive more or less safely in the foundry, is a question that would take some answering.

Scrap Handling Charges High.

In handling charges alone, scrap must cost the metal trade and its carriers, whether railway company, road transport or barge proprietor, a pretty penny before it arrives at its final and predestined resting-place, the crucible. Compare the transit of Chile bars, on their 6,000-mile journey from South America, with a parcel of copper turnings travelling from a railway works in the North to one of the Midland foundries. About four hoistings will see the rough copper safely to its destination, but whether the turnings (admittedly one of the black sheep of the great scrap-metal family) are packed in barrels, bags and drums, or whether they travel in a closed or sheeted truck, the amount of sheer manual labour involved is enormous.

Perhaps one of the most difficult types of old material to handle is wire, unless, of course, it has been knocked up or compressed into a handy form before despatch. Hard springy wire is particularly troublesome and may even prove dangerous, unless the men working on it are equipped with suitable protection to hands and legs. This type of scrap is sometimes sent forward packed in large containers from which it must be dragged by hooks, and the degree of labour essential before anything like homogeneity of form is reached makes the stuff a very doubtful bargain at any price.

Scrap Dealers Should Use Bundling Presses.

It may well be argued that dealers have no right to send into the foundries parcels of scrap which are not at least in manageable form, and that the business of reducing awkward material, such as wire, turnings, old boilers, springy shearings, etc., to a compact form suitable for pot work is essentially one which should be undertaken by houses dealing in old metals, and not left for the manufacturers of castings, rolled metal, etc., who have more than enough to contend with in the management of a factory.

Confronted with the task of reducing unwieldy and bulky scrap to a size suitable for his pots, the foundryman is faced with the certainty of losing money on his purchase unless his shops are equipped with baling and compressing machinery. Such equipment occupies space, means an almost entirely unremunerative capital expenditure, and eats up money in power and labour. But can the manufacturer, whose practice it is to melt 60 or 70 per cent. scrap in his heats, safely dispense with such a safeguard?

The buyer of scrap in this country very soon realises that unless he ties his supplier down to definite measurements, and insists upon form and size being clearly described in the contract, trouble lies in store for him. The term "crucible size" may mean almost anything, for in these days of big tilting furnaces, the range in the capacity of pots in use in our foundries is considerable. "Handy bundles" is another descriptive term much favoured by scrap dealers, but resented by buyers, who find in practice that the conception of what constitutes a "handy" size can vary enormously.

Scrap material is, and always must be, an uncertain purchase, and it behoves manufacturers to satisfy themselves that a monetary advantage over virgin metals still exists after the material has been finally put into a form in which the foundry can handle it for melting.

Notes from Germany.

At the present time the situation of the steel foundries is relatively good, although prices are still very depressed. The Association of Steel Founders is to meet shortly in Berlin, when the question of forming a syndicate for this branch will come up for discussion. It will be remembered that the question formed the subject of lengthy negotiations a year ago, but eventually these had to be broken off owing to the many difficulties which were encountered in coming to an agreement.

The Influence of Nickel and Silicon on an Iron-Carbon Alloy.*

By Arthur B. Everest, Ph.D.; T. Henry Turner, M.Sc.; and Professor D. Hanson, D.Sc. (Birmingham).

(*Continued from page* 32.)

Machinability.—A qualitative indication of the machinability of the alloys investigated is given in the diagram, Fig. 8. The diagram is based on general observations of the ease with which specimens might be cut with a hack-saw. The shaded areas correspond to the compositions of alloys not readily machinable. The area in the bottom left-hand corner of the diagram corresponds to the existence of the hard white austenite-cementite eutectic in the specimens, and the second, larger area, to the martensitic condition of the alloys.

The first area is not modified in shape by heat treatment of the iron, but the second is much diminished in size on annealing; all specimens in this area having less than 3 per cent. Si became machinable on annealing for one hour at 850 deg. C., or for six hours at 650 deg. C. Again, certain specimens in this second area could be rendered machinable by quenching or chilling, when an austenitic structure was obtained in place of the austenite-martensite; for example, the small sections of the casting of specimen No. 28 were much more readily machinable than were the heavier sections. The very high-nickel alloys were very soft, and could be cut with a knife. There was a slight tendency for these to drag on cutting, but the graphite present in the metal prevented this effect from becoming serious.

Hardness of Alloys.—Hardness determinations were made on all sections of each casting. After trial with various sizes of balls and various loads, a standard Brinell test using a 2-mm. ball and a load of 120 kg. was adopted, this being the largest size of test permissible on the small $\frac{1}{2}$-in. section of the castings. The test on the 1-in. step was taken on the polished face of the microsection test-piece. The tests on the other sections were taken on the under face as cast of each step, the skin of the casting being ground away to a depth of about $\frac{1}{32}$-in.

The results of the tests on the three long series of alloys are given in the curves shown in Figs. 9, 10 and 11, and show the effect of the addition of nickel "F" shot on the hardness of each thickness of the casting. The figures given are in each case the mean of two or three determinations.

Fig. 9 shows the effect of the nickel additions on the initial iron without the addition of extra silicon. It will be noticed that in each curve there are two maxima. In the light of the micro-analysis of these series given above, the explanation of these curves is as follows:—The effect of very small additions of nickel was indefinite, owing to the unsoundness of the specimens, but as soon as the specimens were sound enough to test, a hardening action of the nickel was noticed. This was very marked on the chilled sections. In this range nickel dissolved in the alloy, but its graphitising influence, being weak, was inhibited by chilling; under these conditions, the nickel hardened the white-iron structure (consisting principally of the austenite-cementite eutectic in this case). This effect is the same, probably, as that noted by Hague and Turner* for silicon in cast iron.

As graphitisation proceeded, cementite gave place to pearlite and graphite, consequently the next portion of the curve shows a drop in hardness; but as more nickel was added the pearlite was rendered sorbitic and then martensitic; this change might commence before graphitisation had reached its maximum, but it always continued after graphitisation was complete, so that the hardness curve shows a rise again while the matrix of the iron was becoming harder.

On adding still more nickel, the martensitic condition of the matrix was passed, and the matrix gradually became austenitic, with a consequent fall in hardness. Once austenitic, the further addition of nickel up to 20 per cent. rendered this matrix gradually softer.

Chilling the irons in this series caused all these changes to be compressed into a small range of nickel additions. Chilling initially inhibited the formation of the graphite-pearlite structure, so that the changes started in the $\frac{1}{2}$-in. section of the casting at a higher percentage of nickel than they did in the larger sections. Once, however, graphitisation had taken place, the effects of nickel and chill worked together to render the pearlite progressively sorbitic, martensitic, and austenitic, consequently the $\frac{1}{2}$-in. section reached these various conditions at lower percentages of nickel than the larger sections. Moreover, when the iron was passing through the martensitic condition, moderate chill, retaining an austenitic structure, caused chilled sections to be softer and more machinable than the heavier sections. In Fig. 9, for instance, at 8 per cent. of nickel, it will be noticed that the $\frac{1}{2}$-in. section was the softest.

The above interpretation of the shape of the curve applies to all the curves of Fig. 9. The 1-in. and $\frac{1}{2}$-in. sections gave curves following each other closely for the small additions of nickel.

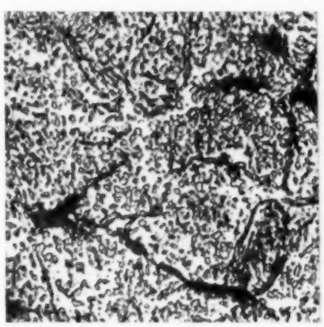

Fig. 24.—Nickel 3.38 per cent., Silicon 1.33 per cent. Annealed at 850 deg. C. for 1 hour. × 500.

Fig. 25.—Nickel 5.16 per cent., Silicon 3.42 per cent. Annealed at 650 deg. C. for 6 hours. ×500.

Fig. 26.—Nickel 7.08 per cent., Silicon 1.39 per cent. Annealed at 650 deg. C. for 6 hours. ×500.

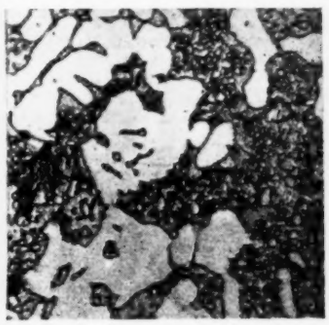

Fig. 27.—Nickel nil, Silicon 0.47 per cent. Annealed at 850 deg. C. for 1 hour. × 500.

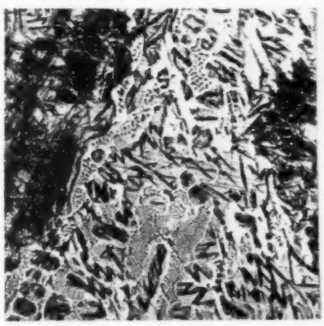

Fig. 28.—Nickel 4.91 per cent., Silicon 0.29 per cent. $\frac{1}{2}$-inch Section. × 250.

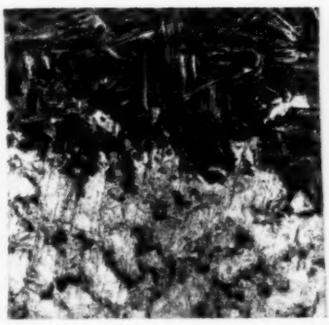

Fig. 29.—Nickel 4.91 per cent., Silicon 0.29 per cent. $\frac{1}{4}$-inch Section. × 250.

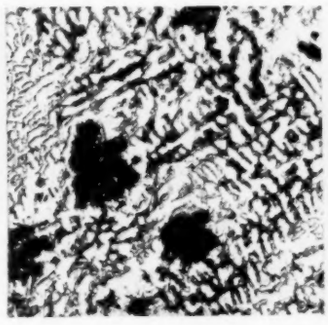

Fig. 30.—Nickel 10.75 per cent., Silicon 0.56 per cent. $\frac{1}{2}$-inch Section. × 100.

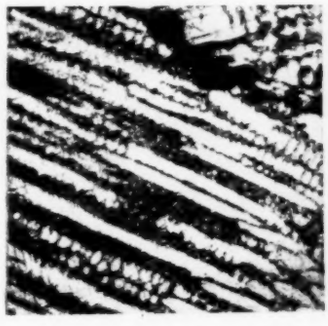

Fig. 31.—Nickel 10.75 per cent., Silicon 0.56 per cent. $\frac{1}{4}$-inch Section. × 100.

* Read before the Autumn Meeting of the Iron and Steel Institute.

* Hague and Turner, "The Influence of Silicon on Pure Cast Iron," Journal of the Iron and Steel Institute, 1910, No. II. p. 72.

The ¼-in. section gave a curve midway between these and the ½-in. section curve. It will be noted that no further changes were shown between 14 and 40 per cent. of nickel, the material being uniformly soft and showing a normal slight hardening effect of chill. Fig. 10 shows the corresponding curves for an iron containing initially 1.2 per cent. of silicon. These curves are of the same form as before, and the same interpretation holds, with the exception that the initial hardening with small nickel additions is not observed, since the presence of 1.2 per cent. of silicon prevented the formation of the austenite-cementite eutectic (except in thin chilled sections), and the graphitising effect of the nickel additions became immediately effective. As is shown in Table III, the first two additions of nickel here continued the graphitisation started by the silicon, and the first effect of nickel was therefore a softening, due to this graphite formation. This was followed by the hardening of the pearlite matrix, and the subsequent soft austenitic condition as before. The effect of chill was the same as for series 0, and it will be noted that the ½-in. section was the softest over a considerable range of nickel additions.

Fig. 11 shows curves for an iron with initially 3.3 per cent. of silicon. At this percentage of silicon, nickel appeared to have little effect on the comparatively coarse pearlite matrix of the iron, when added in small quantities. Finer graphite was observable, and is reflected in the curves as a hardening on the larger sections of the castings. This effect was followed by a slight softening, more marked in the smaller sections of the casting. In this range the microstructure was a coarse pearlite, with traces of free ferrite. Further nickel, however, caused a hardening of the matrix, which changed to a martensitic form, followed by a gradual softening through austenite-martensite structures, as in the previous cases. These curves show how, with different amounts of silicon initially in the iron, very different effects may be obtained by the addition of nickel; this may explain some of the very contradictory reports concerning the effect of nickel on the hardness (and other properties) of cast iron.

Magnetic Properties.—Qualitative tests only were made on the magnetic properties of the alloys. In Series 0, the low-silicon iron specimens were attracted by a magnet with decreasing intensity above 5 per cent. of nickel. The specimen with 14 per cent. of nickel was only very feebly attracted, and the specimen with 19 per cent. of nickel was almost non-magnetic. Further additions of nickel, however, up to 40 per cent., caused a progressive return of the magnetic properties in the specimens. With 1.7 and 3.6 per cent. of silicon, the specimens with 14 per cent. of nickel were still feebly attracted to the magnet.

Further Tests.

For further tests, consisting of determinations of density and resistance to corrosion and a study of the effect of annealing on the microstructure and hardness, specimens representative of the whole series of alloys investigated were selected, the selection being based on the structures of the alloys. The specimens selected were as in Table VII.

Table VII.—*Specimens Representative of the Whole Series.*

No.	Nature of alloy.	Nickel. Per cent.	Silicon. Per cent.	Density.
10	White iron	0	0.47	7.641
20	Pearlitic	0	0.66	7.372
22	,,	0.96	0.68	7.363
25	,,	2.36	0.74	7.351
42	,,	1.10	1.27	7.353
62	,,	1.02	3.32	7.211
07	Sorbitic	4.91	0.29	7.435
26	,,	3.38	1.33	7.401
66	,,	5.16	3.42	7.243
28	Martensitic	7.08	1.39	7.375
67	,,	7.47	3.43	7.182
011	Austenitic	19.10	1.35	7.543
014	,,	39.22	2.58	7.556
69	,,	13.72	3.65	7.262

Density.—Specimens were cut across the ½-in. step of the casting and ground smooth all over, giving a test-piece approximately 1½ in. × ½ in. × ½ in. The density determinations were made by Archimedes' method. The results, given in Table VII, call for little comment; they all lie within the limits normally given for grey and white cast irons. It will be noted that the density fell fairly rapidly as the silicon increased, whereas nickel caused only a slight decrease, followed subsequently by a gradual increase in density with larger additions. The density measurements indicate the general soundness of the alloys cast.

Resistance to Corrosion.—Samples cut from the specimens indicated in Table VII were submitted to Mr. E. C. Dickenson, B.Met., of the British Cast Iron Research Association, who kindly conducted the corrosion tests, in which the loss per unit area on a circular face of the specimen, 1 in. dia., in sulphuric acid of strengths varying between 0.5 per cent. and 20 per cent. was determined. The results show that the samples containing nickel, which had a pearlitic, sorbitic, or martensitic ground-mass, generally offered a resistance to attack in the acid inferior to that of an ordinary engineering grey cast iron. The austenitic samples showed very marked resistance, the specimens containing about 20 and 40 per cent. of nickel being practically unattacked by the strengths of acid used.

The conclusion from the tests in "normal" acid (about 5 per cent. by weight), in which solution the greatest loss of weight of the samples generally occurred, is that in a pure iron-carbon alloy containing silicon, with increasing nickel, there was a slight increase in the rate of corrosion up to 1 per cent. of nickel, with a subsequent falling off of the rate at about 2.5 per cent. of nickel, followed by another increase, until at 4 to 7 per cent. nickel the rate of corrosion was nearly twice that experienced with a good-quality grey iron. On further increasing the nickel content, there was a rapid improvement in the resistance to attack, and with 15 to 20 per cent. nickel the alloy was highly resistant to sulphuric acid.

It should be remembered that the above results refer to corrosion under one set of conditions only, and it would be unwise to draw too general conclusions from them.

Influence of Annealing.—Samples, cut from the ½-in. step of the alloys indicated in Table VII, were used for the annealing experiments. The test-pieces were cut to ½ in. × ½ in. × ⅔ in., and to reduce oxidation to a minimum they were coated with alundum cement to a thickness of about ⅛-in. and dried in a steam oven. They were placed on asbestos in an electric resistance furnace large enough to ensure uniform heating of all the specimens. Temperature measurement was effected by means of a base-metal thermocouple, the hot junction of which was placed in the middle of the specimens, coupled up to a millivoltmeter, and for the long test, to a thread recorder. Two annealing experiments were conducted, each on a separate set of samples:—*Test* 1.—Annealing at 650 deg. C. for about six hours; and *Test* 2.—Annealing at 850 deg. C. for one hour.

Table VIII.—*Machinability.*

No.	Machinability.			Brinell hardness.		
	As cast.	Test 1.	Test 2.	As cast.	Test 1.	Test 2.
10	Unmach.	Unmach.	Unmach.	264	291	310
20	,,	Mach.	Mach.	181	177	141
22	Difficult	,,	,,	189	170	134
25	Mach.	,,	,,	196	176	153
42	,,	,,	,,	212	192	155
62	,,	,,	,,	187	170	98
07	,,	,,	,,	248	192	187
26	,,	,,	,,	235	207	170
66	,,	,,	,,	166	100	103
28	Unmach.	,,	,,	235	212	119
67	,,	Difficult	,,	205	116	118
011	Difficult	Mach.	,,	105	149	101
014	Mach.	,,	,,	95	79	79
69	Unmach.	,,	Difficult	130	147	153

In each case the specimens were placed in the cold furnace, heated up to and held at the desired temperature for the required time, and then allowed to cool in the furnace. Heating up took about one hour in Test 1 and about 1½ hours in Test 2, and cooling to room temperature took about sixteen and twenty hours respectively. When cold the specimens were cleaned, cut into two, and the inside face polished for micro-examination. The specimens were very little oxidised.

Machinability.—In Table VIII some indication of the machinability of the specimens is given before and after annealing. It is interesting to note that, except for the original white iron, all specimens became machinable after each anneal.

Microstructures of the Annealed Specimens.—The results of micro-examinations are given diagrammatically in Figs. 12 and 13. The numbering of the fields is the same as that used in Fig. 7. In fields 1, 3, and 4 (Fig. 12) the structure was little modified on annealing at 650 deg. C., except that the pro-eutectoid cementite was rendered globular. With nickel over 2 per cent., however, the pearlite became less stable, and on annealing tended to break down. The first stage of breaking down was the spheroidisation of the pearlite, as shown in Fig. 24; this occurred with low-silicon alloys. With high-silicon, however, this treatment proved sufficient to cause the complete decomposition of the structure to ferrite and graphite, as shown in Fig. 25. These two micrographs correspond to the structures in fields 8 and 9 respectively.

With higher additions of nickel, martensite appeared in a state of decomposition after annealing as shown in Fig. 26. This is shown continuous with field 8, since the products of decomposition were the same as for the pearlite—namely, globular cementite and ferrite. At the high-nickel end, this field extends much farther into the austenitic field (7) after annealing. After the higher-temperature annealing, the alloys in fields 1 and 4 (Fig. 13) were found to be comparatively stable, except that the carbides tended to become globular. This is demonstrated by Fig. 27, which shows the low-silicon alloy after annealing. With higher silicon a field of partial decomposition of the pearlite was found (field 8), and beyond this—the major part of the diagram, a field of complete decomposition of the structure to ferrite and graphite—field 9, Fig. 25.

Specimen 69 became martensitic on this annealing, and the change was confirmed by the hardness values given by this specimen. The presence of this martensitic field (6) suggests that it must be adjacent to an austenitic field, and that there should be a zone between fields 7 and 9 somewhere in the position XY.

Fig. 13 indicates that the addition of nickel to the iron-carbon alloy rendered the latter less stable on annealing, but that the action of nickel was here again much more feeble than that of silicon. Specimen 07 containing 5 per cent. of nickel (and 0.3 per cent. silicon) proved comparatively stable during the second anneal, whereas specimens with 2 per cent. or over were decomposed. The direction of the field boundaries in Fig. 13 indicates that silicon and nickel produced the same effect, but that four times as much nickel was required as silicon.

In the light of these microstructures, the machinability and hardness figures in Table VIII require, for the most part, little further explanation. For the lower nickel specimens, softening was obtained on annealing, corresponding in general to the gradual decomposition of the structures. Round about 20 per cent. of nickel, however, annealing caused initially a breakdown of the austenite to martensite, and with further annealing the latter gradually decomposed. These specimens became harder at first, and also less machinable, and lost their non-magnetic properties. It is of interest to note that in practice irons corresponding roughly to this structure become markedly hardening on working. Table VIII shows also, in the cases of specimens 28 and 011, that with mixtures of austenite and martensite specimens with very low Brinell hardness values might be obtained which were yet unmachinable.

Further work on the heat treatment of these alloys must be undertaken before the results are fully understood; the results reported here are intended merely to indicate the types of change obtained with specimens representative of the series of alloys investigated.

Influence of Thickness of Casting on Microstructure.—The microstructure of the thin sections of some of the castings was examined, these sections corresponding to different degrees of chill. The results are, in general, as would be expected of the influence of chill on the structures of the alloys.

As an example specimen 07 (Ni 4.91 per cent. and Si 0.3 per cent.) may be considered. The microstructure of the 1-in. section (Fig. 18) consisted of a ground-mass of sorbite carrying cementite crystals and graphite. At the tip of the $\frac{1}{8}$-in. section, where chilling was most violent, an austenite-cementite structure was found, in which the austenite areas were retained in that condition or were breaking down to martensite. Towards the centre of the $\frac{1}{4}$-in. step, the austenite-cementite eutectic occurred side by side with the austenite-graphite eutectic, while the primary dendrites of austenite were still found in the martensitic condition (Fig. 28). In the $\frac{1}{4}$-in. step of this casting round areas of primary austenite broken down to sorbite were found embedded in large areas of austenite-graphite eutectic with the austenite in the martensitic condition (Fig. 29). In larger sections the specimen became completely sorbitic, Fig. 18.

Specimen 09, with 10 per cent. Ni and 0.56 per cent. Si, showed in the 1-in. section a mixture of austenite with a little martensite. On chilling this specimen, the austenite was retained in all the smaller sections. In the $\frac{1}{8}$-in. step at the tip a fine austenite-cementite eutectic structure was obtained, while in the centre of the step the austenite-graphite eutectic was in predominance; the transition structure between the two is shown in Fig. 30. In the $\frac{1}{4}$-in. step a structure consisting entirely of primary austenite and the austenite-graphite eutectic was found (Fig. 31).

Some high-silicon specimens were examined. In them all the graphite occurred in the chilled sections in the eutectic form, the ground-mass being sorbitic, martensitic, or austenitic, according to the nickel content, and the structure in all cases being very fine.

To sum up, it may be stated that on chilling, fine dendrites of austenite were normally found associated with the austenite-cementite eutectic or with the austenite-graphite eutectic, the former eutectic being obtained with the greater chill, but not being seen in the high-silicon specimens. The austenite, both primary and eutectic, then appeared broken down to martensite or sorbite to a degree depending on the amount of chill and the nickel content of the iron. The structures obtained on chilling were always fine, and graphite occurred only in the eutectic form or in nodular areas of fine flakes (Fig. 30).

The authors wish to express their appreciation of the very helpful co-operation of the British Cast Iron Research Association, through its Nickel Committee; they would like specially to thank Mr. J. G. Pearce, B.Sc., Director of Research, and Mr. S. E. Dawson, Chairman of the Nickel Committee. They are also pleased to acknowledge the help of Mr. E. C. Dickenson, B.Met., by whom the corrosion tests were carried out. The results are published here by kind permission of the British Cast Iron Research Association. The research has been made possible by the provision by the International Nickel Company of Canada, Limited, of a Research Fellowship in the University of Birmingham. This Fellowship is at present held by Dr. Everest.

Discussion.

Prof. C. H. Desch, in opening the discussion, said the Paper afforded some accurate information as to the effect of nickel on cast iron, about which a good deal of inaccurate work had previously been published. He presumed that the authors intended to continue with the work because it would be particularly interesting when they dealt in future with the more complex system of nickel-chromium cast iron, which seemed to him to be one of the most promising materials for use at present.

Mr. T. Henry Turner said the work referred to in the Paper had been carried out by Dr. Everest, who was working under the direction of Prof. Hanson. By an examination on the spot he satisfied himself that nickel was actually being added to the commercial cast iron in ordinary every-day routine works' practice in many of the best North American foundries, and that was in relatively small quantities of high-grade cast iron. So far as he was aware a similar practice did not exist in Europe, and the published data was so contradictory that it could not be regarded as wholly reliable. He looked round to see why that difference should exist. He noted that the Americans were using a low total carbon by diluting their cast iron with steel scrap, that the Northern irons had a low-phosphorus content, but when nickel was added it reduced the ordinary silicon content. In all the works that he visited nickel was being added in the form of a low-melting-point alloy. So far as he could see, the authors' results confirmed those obtained in the American works in so far as the combined influence of nickel and silicon were concerned, and also confirmed the result that nickel could be added to cast iron successfully in the form of a low-melting-point alloy, nickel-silicon shot in that case. The latter point was worth emphasising, because during the time the experiments had been carried out at Birmingham, another European worker had endeavoured to add nickel to cast iron in the form of pure nickel shot placed at the bottom of the ladle, but with unsuccessful results. The difference between the success achieved at Birmingham and the failure of that European worker might be the explanation of the varying results obtained in the experiments recorded in the literature referred to in the Paper. It was hoped in the near future that further experiments would show the influence of phosphorus, chromium and total carbon variations in conjunction with similar additions of nickel.

Prof. D. Hanson said that reference had been made to the addition of nickel in the form of nickel-silicon alloy to cast iron, that being the way in which it was added in the work that Dr. Everest had carried out. He desired to make it quite clear that it was not suggested that that was the only way in which nickel could be added to cast iron. It was being added successfully in that way, but it was also being added quite successfully in the form of pure nickel shot to the ladle and small ingots of pure nickel through the cupola. Some people had trouble when they added nickel, but if the metal was hot enough it could be done quite successfully in that way, as it was being done not only in America but in this country.

Corrosion by Oil.

Before a meeting of the Institution of Petroleum Technologists, held at the Royal Society of Arts on Tuesday last, Mr. Horace J. Young read a Paper on "Corrosion by Oil." Severe corrosion having occurred on the pins and journals of the crankshafts of two motor ships, it fell to the author to ascertain the cause, and, if possible, to find a remedy. The corrosion was found to be due to corrosive matter in the lubricating oil, and the author describes how he traced it by means of what he calls a direct oil-corrosion test (D.O.C.).

The test is performed by means of an apparatus whereby warm oil is run continuously over warm steel, white metal, brass, copper, or any other metal. The temperature employed by the author was 10 deg. C. below the boiling point of water, but may be any temperature demanded in any particular case. In order to reproduce the conditions of the pins and journals, slabs were cut from similar steel, and one-half of their surfaces "white-metalled" with bearing metal of the same make and quality as that used on the engines. It was possible, therefore, in one and the same test, to observe the effects of the oil upon the steel, the bearing metal, and at the point where the two materials met—as a matter of fact, over many experiments, there has been no definite indication of increased activity at this junction. The testing apparatus described in the Paper is of simple construction.

By the D.O.C. test as little as 0.002 per cent. H_2SO_4 can be detected, and the test is equally sensitive to minute amounts of sea-water, alkalis, sulphates and so on. The alkalis so readily affect white metal that an oil cleaned by alkali will attack white metal even when that oil has been washed three or four times with water. The test thus affords a means of testing the efficiency of any cleaning process. In this connection it has led to the perfecting of a simple appliance which, inserted into an oil-system, will keep the oil "sweet." The study of compound lubricants as used on compressors is greatly facilitated, and, at the time of writing, valuable information is being obtained as to the effects of high acid value (oleic), high saponification number, and so on.

In practice the D.O.C. test is being used as a means of watching the oils on internal-combustion engines for land or marine work, and within a few hours of receiving the sample it is possible to tell the owners whether their oil is becoming dangerous to use. Corrosion in pipe-lines is not unknown, and the work of discovering its progress, cure or prevention may be facilitated by this test. The original work in connection with this oil test was done at the works of Messrs. Swan, Hunter & Wigham Richardson, Limited, Neptune Works, Newcastle-on-Tyne, where the importance of the results was recognised and made use of.

Technical Research Work in Sweden.

Up to the outbreak of the war the Swedish Jernkontor held a central position with regard to scientific investigation and technical research work in the iron and steel industry of the country. The sudden expansion of this industry brought about a movement towards extended metallurgical research, resulting, among other things, in the establishment of large and well-equipped laboratories at the leading steelworks. During the same period a number of other institutions, such as the University of Technology at Stockholm, the Academy of Engineering Science and the State Testing Institute, extended their departments for iron and steel research work. The Metallographical Institute was also founded. In course of time it was found that decentralisation and a certain amount of overlapping became inevitable. In order to obtain an increased efficiency and greater economy it was therefore thought necessary to establish some system of co-ordination and collaboration between the different institutions and laboratories. It was only natural that this task should be taken in hand by the Jernkontor. A special committee was appointed for that purpose and the following plan was eventually adopted by the Council.

The general research work is carried out under the supervision of four committees, each concentrating attention on one of the following subjects: (1) Mining, including ore separation. (2) Pig-iron production, briquetting, ore-sintering and charcoal-hearth work. (3) Steel-making, including production of steel castings. (4) Rolling, forging and heat treatment. The first two committees are composed of four, the latter two of six members, apart from the Chief Engineer of the Jernkontor, who is a permanent member. This position has for a number of years been held by Mr. Axel Wahlberg, this year's Bessemer medallist. The Secretary of the Jernkontor, Dr. Alf Grabe, will act as deputy for the Chief Engineer. Members are elected for a period of two years, but a provision for re-election is made.

The objects of the Committees will be to keep developments within the iron and steel industry under observation, to examine problems submitted by the Jernkontor, and to investigate such questions affecting the industry as have been raised within the Jernkontor as such, by its individual members or in other quarters. Scientific institutions and steelworks alike are represented on the Committees, and the hope is entertained that this organisation will lead to increased collaboration, and a more efficient utilisation of the forces now at work for the scientific and technical progress of the Swedish iron and steel industry. In addition to this organisation of supervising and investigating committees, the Jernkontor has placed at the head of the research department Mr. Arvid Johansson, Professor of Blast-Furnace Mechanics and Steel Treatment at the University of Technology, who is at present engaged on elaborating a definite programme for the organisation of the new Institute.

We are officially informed by Messrs. Vickers, Limited, that Mr. Alfred Cartwright has resigned his seat on the board, and that at a meeting of the board held last Thursday General Sir Noel Birch, K.C.B., K.C.M.G., and Mr. G. G. Sim, C.S.I., C.I.E., the secretary of the company, were appointed directors.

Open-Hearth Steelworks Refractories.*

By A. T. Green.

Silica bricks vary very considerably in constitution and physical properties, and an investigation of the classes of product used in the open-hearth furnace indicates that many differing varieties are used, apparently with equal success. Generally speaking, from a purely technical point of view, the quality of the products, particularly regarding the consistency of texture, used for the steel furnace does not appear to be equal to that required for the carbonising industries. The texture of silica bricks used in the steel industry is, in general, of a coarser nature. By this is meant that there is an appreciable quantity of fragments of size up to and sometimes over 0.3 or 0.4 in. dia.

Naturally from the nature of the open-hearth operation a resistance to spalling is required. It is almost an axiom that, other factors being constant, the coarse-grained material resists the influence of spalling better than the fine-grained one, because cracking can take place in a more continuous manner in the fine-grained product. For this reason, coarser textures are certainly superior for the roofs of the furnace. However, this statement is capable of misunderstanding, since the mere excess of coarser fragments is no criterion of the value of the brick for the purpose in question. The grading of the original fractions is most important. In the original grading it is desirable to have both an excess of the coarse fragments and of the very fine or "flour" fraction. This latter material determines the matrix formation and the alteration in the nature of silica, both of which phenomena take place during the high-temperature phase of the firing. The matrix formation and the angularity of the larger particles mainly determine the strength of the product, a factor of considerable importance in all structural work.

Bricks for Port and Top Courses.

For port bricks an approximation to 40 per cent. through 120 screen appears to the author to be highly desirable, since with correct firing it will allow the formation of an adequate amount of matrix. As a help in increasing the strength of silica brick for steel-furnace work, W. J. Rees suggests the addition up to about 2 per cent. of finely-divided ferric oxide. For the ports and top courses of the regenerators, the silica bricks should not possess excessive porosity. In general, however, the finer the texture the lower the porosity. This argument may lead to the assumption that a fine texture is requisite for these particular positions. To the author, this opinion does not appear to be altogether correct. A certain amount of the coarser fractions is very necessary as a resistant to spalling, the final porosity should not be greater than 27 per cent. Actually, then, there should not be a great deal of difference between the texture of the roof and the port bricks, the roof material being somewhat coarser. However, a difference in the degree of vitrification, *i.e.*, the firing treatment, may alter the properties somewhat. The angularity of the fragments is of particular significance in promoting high mechanical strength, and thus it is definitely advantageous to obtain this feature in the "ganister" mix.

It is a well-known fact that the constitution of silica products is determined in the main by (1) the nature of the original raw materials, *i.e.*, the ganisters; (2) the manufacturing procedure, particularly respecting the grading of the raw material and the nature and amount of flux used, which is generally hydrated lime; and (3) the control and the extent of firing. Consequently, it may be anticipated that there is a considerable variation in the constitution of different products. The physico-chemical explanation of the main variation lies in the fact that silica has the property of existing in several crystalline modifications whose physical properties differ widely. Quartz, which is the stable modification at ordinary temperatures, is the one usually met with in nature and forms the basis of the ganisters used in the production of silica products. Under the influence of continued high temperatures, over 1,000 deg. C., the quartz may be transformed into either or both of the two other forms, *i.e.*, cristobalite and tridymite. These changes are accelerated by the presence of flux such as lime, which is the common agent used in the manufacture of silica bricks. Such an acceleration appears to be due to the solvent action on silica particles of a viscous complex calcium silicate—formed primarily by the interaction of lime and finely-divided silica. This solvent action is followed by the precipitation of the dissolved silica in the form of cristobalite. Thus, in any well-burned lime-bonded silica brick, the presence of tridymite, cristobalite, and quartz, together with from 5 to 15 per cent. of a glassy matrix of a complex calcium alumino-silicate, must be considered.

Highly-Converted Silica Unsuitable for Open-Hearth.

The presence of highly-converted silica in silica bricks, particularly cristobalite, enhances the spalling tendency at low temperatures between 100 and 250 deg. C. Thus the furnace constructed of silica bricks, especially highly-converted material, must be very carefully heated past the danger zone. To obtain highly-converted products, high-temperature firing conditions, finely-graded material, and excess of lime are usually the factors most assiduously controlled. It is comparatively easy to obtain high conversion with excess of lime and a fine-textured mix. The steel-furnace product, however, requires the coarser mix, and further it appears that excess of lime influences the corrosion and erosion, and reduces the elasticity of the product, *i.e.*, increases the tendency to spall at lower temperatures. Thus, in general, very highly-converted silica bricks are not frequently found in the open-hearth furnace.

High percentages of lime tend to the production of larger amounts of matrix, which become comparatively fluid at high temperatures. This causes a definite softening of the brick at the high temperatures of its use. Such a softening may be advantageous or otherwise according to its degree. Thus, if the softening is too excessive, the structure loses some of its stability; while in other cases, a desirable amount of viscosity of the matrix may serve to take up the strain, induced by any changes of quartz to the other low-temperature forms during industrial usage. It is obvious, then, that the matrix formation must not be too excessive, and the matrix itself must possess that viscosity which will ease strain in the structure without undue softening. A lower percentage of lime is much more likely to give this compromise than a high one.

The true specific gravity is in some measure a guide to amount of conversion a silica product has undergone during firing. Thus, a straight silica brick of specific gravity from 2.32 to 2.35 is very highly converted. An examination of a number of bricks used in open-hearth furnace construction shows that, generally, the specific gravity varies from 2.42 to 2.47. In a few instances, values over 2.50 were obtained, but these are not looked upon as desirable values. Values in the vicinity of 2.42 seem to be associated with bricks giving most desirable service. Thus, it can be seen that the most prevalent silica bricks in the industry may be classed as "medium" converted products, and must in consequence contain an appreciable quantity of unconverted quartz. This may be explained by the presence of the larger fragments, which are, of course, very difficult to convert except at their edges.

A Compromise of Properties Essential.

In the main, for "straight" silica bricks the amount of after-expansion is allied to the true specific gravity, so much so that a low value of the latter property is associated with low after-expansion. With coarse-grained products, as shown by W. J. Rees, this does not hold altogether, and appreciably low values for the after-expansion are shown by products possessing specific gravities in the neighbourhood of 2.42. This is obviously accounted for by the slower rate of conversion of the larger grains. In furnace construction, expansion allowances, based on the empirical experience with specified materials, are always made. Naturally, by using very highly-converted material, this allowance could be reduced. It seems, however, that only a compromise of properties is possible, since there is an exceptional heat treatment necessary to convert the coarser-textured product to a full degree, it is advisable to have a product of specific gravity of, say, 2.42, with enhanced resistance to spalling and corrosion, at a reasonable cost and make allowances for expansion, than to have a very expensive, highly-converted product with less expansion, but with the possibility of the introduction of spalling strains during the initial heating, a softening at high temperatures, and a liability to excessive corrosion. It is feasible that the formation of too vitrified a matrix increases the spalling tendency at low temperatures, by increasing the rigidity and decreasing the elasticity of the product.

It is a well-known fact that during the high-temperature usage of silica bricks, the unconverted quartz tends to be transformed into the low-specific-gravity forms, and that these transformations are associated with large volume changes. From this point of view, a material which is not totally converted must show a tendency to expand at high temperatures, if there are no factors militating against this expansion The main unconverted portions of the coarser-grained product in question are the larger fragments of silica. Because of their size, the rate of conversion of these grains will be comparatively slow. Further slagging is taking place simultaneously with these changes, and consequently the effects of the expansion will probably be taken up by a more fluid material. Thus the strain effects of continued conversion should be, in some measure, neutralised.

Corrosion and Erosion of Open-Hearth Silica Bricks.

The circumstances attending the operation of steel-making are such as to cause excessive corrosion and erosion. The temperature and velocity of the gases leaving the bath by way of the ports are in the neighbourhood of 1,550 deg. C. and 150 ft. per sec. respectively. These gases are laden with dusts of a calcareous and ferruginous nature, so that the circumstances for rapid wearing away are very complete. Thus, the wear and tear of silica bricks at the ports is, to a certain extent, due to the abrasive action of fine basic dust swept through the furnace by the gases. Other factors accounting for this process of denudation are high working temperatures, local effects of flame, dust in the materials charged, liquid metal from the bath and charge, and the spurting of slag during boiling of the bath. To maintain the structure of the ports under the conditions of their use, devices such as water-cooling have been tried with reported success. The principle of such a device is of course thermally uneconomical, so that any attendant advantages must be carefully considered before adoption. The roof bricks are subjected to corrosion and erosion to a pronounced degree, but there are reasons to assume that the mechanism of this phenomenon is different from that at the ports. Clements bases his conception of the desirable state of affairs in the upper zones of the open-hearth furnaces, on the assumption that the hot moving fluid is confined to the regions of the bath, and that the atmosphere in the neighbourhood of the roof is comparatively stationary. If this is generally the case, then the constitution of this upper atmosphere must be one of the predominant factors in the extent of the "iron" penetration and corrosion. There are reasons to suppose that the nature of the gases does play a big part in the corrosion of steel-furnace roofs.

In actual practice, the roof of a furnace is often eaten away by the impingement of flames, burning with intense heat. Thus, if the gas is very light, that is, it contains an excess of hydrogen, or if the ports have lost their contour, then there is a mal-direction of the gases, with consequent rapid

* Extracted from a Paper presented to the Annual Meeting of the Ceramic Society, held at Bournemouth, Mr. H. J. C. Johnson presiding.

fusion of certain portions of the roof. Any economical device of design and construction, which aids in maintaining the true direction of the flame, is of great importance to the steel maker, since the effective life of the furnace, and therefore its fullest economic working, is guaranteed. In passing, it may be mentioned that the maintenance of the contour of the ports, and therefore the direction of the gases, is one of the advantages claimed for the water-cooling of the ports. A feature which has been noted by the author in the early stages of work with a newly-constructed furnace is the "peeling" of silica bricks in the roof. This appears to be associated with the development of a slag or "glassy" layer on the surface of a brick, and by reason of its different variation of expansion with temperature, tends to pull away a thin layer of the silica brick. It is particularly prone to occur with fine-textured bricks, but is common with the coarser grained products.

Mechanism of Corrosion and Erosion.

Features concerning the corrosion and erosion of roof bricks have been adequately described and explained by a number of investigators, chiefly including E. Renegade, J. E. Stead, and C. S. Graham, while A. Scott has contributed a valuable theory concerning the general mechanism of the corrosion of steelworks refractories. These researches have been used extensively to supplement works' observation made by the author. An analysis of the factors involved in corrosion indicates that at least two features, often acting together, are definitely concerned with this phenomenon. The first is the interaction which takes place between the corrodant, *i.e.*, the slag or dust, and the material forming the surface of the refractory. The second is the passage of slag, or dusts, or substances formed by superficial action into the body of the refractory.

The physical condition of the corroding agent has a profound influence on the nature and extent of the action. With a slag, for instance, the viscosity, temperature, and constitution all play their part. Depending on the constitution and temperature, the solvent action of the slag for the refractory material is determined, while on the viscosity both of the corrodant and its resultant slag after dissolving other substances, depends the rate of passage into the interior of the refractory mass. It is not to be assumed that the solution of material necessarily makes the slag more viscous. The viscosity may be increased or reduced according to the nature and amount of the substance dissolved. Further, the viscosity does not necessarily vary linearly with temperature, and consequently the precise behaviour of any corroding slag is hard to define.

The fact that refractories are essentially composed of crystalline and amorphous or glassy substances has a bearing on their relative corrodibilities. Thus a silica brick with a well-developed matrix may be more prone to attack, owing to the probable greater ease of solution of this glassy substance. Scott gives a good example in quoting his observation of a silica brick in the port of a furnace. The dust had penetrated and attacked the matrix without greatly altering the grains of unconverted quartz fragments. On the other hand, of course, greater development of matrix in a brick may mean lower porosity, which is a factor militating against corrosion.

The passage of dusts and slags may take place by way of the pores or by way of the matrix. The nature of the porosity plays a big part, and consequently a mere measure of the percentage porosity is hardly an effective guide to the influence of the pore-spaces. Some measure of the penetrability, that is a test based on the rate of flow of fluids of varying viscosities, may help in the understanding of this passage. At the present time, however, it is a property difficult to comprehend, because it is difficult to obtain quantitative data concerning it. In the circumstances of the penetration of slags into the interior, there can be little doubt that capillarity has a great influence. Especially is this so with the roof bricks of the open-hearth furnace, where there is definite evidence to show that this tension is particularly effective in drawing the fluid, complex iron silicates formed on or near to the surface into the interior of the brick.

As already mentioned, the matrix because of its "glassy" state often aids in the penetration of the corrodant, directing its passage. There is definite evidence which shows that at the temperature of the open-hearth furnace this matrix is molten, so that when dusts and slags come into contact with it there is a tendency for it to diffuse to cooler regions. That the concentration of lime is greatest some distance from the hot end at a point where the amount of slaggy material is very low, serves to illustrate the point.

Bricks from Furnace Roofs.

Examination of bricks taken from the roofs of steel furnaces shows definite characteristics. Generally, the bricks are divided into four or five zones—passing from the quondam hot end to the cold end—each with more or less definite characteristic, particularly respecting the constitution. The petrographic investigation of these zones is very interesting, since it shows the development of tridymite, in degrees dependent on the heat treatment and fusible slag content. In general, the indications of the examinations may be written as follows:—

(1) The fusible silicates formed at the surface of the brick after combination with oxides of iron and calcium, flow upwards into the cooler but still highly-heated portions of the brick by capillary attraction and become concentrated at a considerable distance from the point where they entered. Thus, lime, alumina, and iron oxides are concentrated at a distance in the interior of the brick. This flowing upwards of the fusible material obviously pushes forward the matrix of the silica brick, for the concentration of lime at the hot end is less than normal, while at a distance of 5 in. from this end the lime content is a maximum, being in the neighbourhood of 5 per cent.

(2) The iron oxide is at its maximum about 2½ in. from the hot end, although there is a considerable quantity at this end itself, where the brick has been near to its melting point. A large quantity of the iron oxide appears to be hard, comparatively very refractory, and according to C. S. Graham, withstands temperature fluctuations without fracture.

(3) Unconverted quartzite is present at a distance of from 4 to 5 in. from the hot end after long working. Scott, however, states that, in his investigation, quartzite particles were noted at the hot end itself. It is, of course, a matter of duration and intensity of working, together with the nature and texture of the original brick.

(4) Stead notes that in the hottest zone, the tridymite has undergone actual fusion, the large crystals being replaced by spherules surrounded by, but not mixed with, the black opaque constituent. At distances from 2 to 6 in. from the hot end, tridymite crystals continue to appear. Nearer the hot end they are very large, but gradually diminish in size and numbers according as the less heated sections are approached. At a distance of 7 in. from the hot end, more or less the normal structure of the brick can be seen.

The influence of the interpenetrated iron oxide and ferruginous slag on the structural stability of refractories is both peculiar and variable. In general, the value of the refractoriness-under-load of firebrick impregnated with ferruginous slag is considerably reduced. In the case of silica products, however, many observers have noted that the absorption of slag or dust rich in iron at high temperatures affects the softening point under load only to a relatively small degree. H. Sieurin, for instance, states that the presence of iron, estimated at 10 per cent. of ferric oxide, has only a very small effect on the under-load value. To the present author, failure or otherwise, is a matter of degree. Iron compounds impregnating a silica brick may be attacked or combined with the matrix, but the interlacing skeleton of silica, mainly in the form of tridymite and cristobalite, may be unaffected. In these circumstances the product may possess definite structural stability. A point, however, may be reached when the strength of the silica skeleton, owing to the solution of the silica, will be reduced to a minimum and failure will follow. Thus, it seems that silica products have the ability to hold ferruginous slags for considerable periods without undue detriment to the structure.

An under-load test on a ferruginous silica brick, taken from a gas retort and containing an average of 8 per cent. of iron oxide estimated as ferric oxide, showed to the present author the squeezing-out of a very fusible iron slag in the neighbourhood of 1,050 deg. C., but the test-piece maintained its identity to a higher temperature than was normal for the unused product. Naturally, the condition of the iron oxide is an all-important factor. It is asserted that in the zone next to the hot end of the roof bricks the "iron" is mainly present as magnetic oxide. This being so the refractoriness of the product will be little impaired by the presence of appreciable quantities of such an oxide.

There appears to be a distinct difference between the corrosion of the roof bricks and the port blocks. This is to be expected from the probable differences in the velocities and nature of the gases at these two positions. The passage of the slag into the port blocks is very likely much faster, and consequently the nature and constitution of the penetrating corrodant is very different. Further, owing to the velocity of the gases and their dust content, the action will be an erosion and abrasion. A. Scott has shown some dissimilarity, but the behaviour of port blocks is so variable that it is difficult to give a definition, such as has been put forward for the phenomena of roof bricks.

Thermal Characteristics of the Chequerwork.

Generally speaking, the chequer brickwork is made of a superior fireclay product, with the top eight courses of silica or a highly siliceous material, so that it is desirable to consider the thermal properties of both classes of brick. The amount of heat taken up per unit volume of a structure, however, depends upon the apparent specific gravity of the structural material as well as the specific heat. Both the apparent specific gravity and the specific heat vary with temperature, and consequently, although the apparent specific gravity slightly decreases in value with temperature, it is easily shown that the heat capacity per unit volume increases rapidly with temperature. The apparent specific gravity of well-burned fireclay products varies from 1.8 to 2.2, and of silica bricks from 1.60 to 1.95, thus the average heat capacity of a firebrick is definitely greater than that of a silica brick. This is interesting in connection with the usual practice of using silica brick for the top eight courses or so of the chequerwork, for it militates, in some measure, against maintaining the high temperatures in the top zones. However, this may not be of great moment, since consideration of slagging must profoundly influence the thermal characteristics at the zone. Further, with the increasing temperatures of working, silica bricks in their top courses are more or less a structural necessity.

It is interesting to note that with increasing vitrification the apparent specific gravity of firebrick is increased. Thus a hard-burned refractory firebrick possesses definite thermal advantages. Also, during the operation of the regenerator the bricks become increasingly vitrified, with the result that the heat capacity per unit volume is increased. Naturally the rate of passage of heat through the brickwork is one of the factors governing the efficiency of chequerwork. Such a factor is referred to as the thermal conductivity. The determination of this physical constant has been the subject of many investigations which, unfortunately, have been productive of widely divergent results. As with the specific heat the thermal conductivity of both silica and fireclay increases very rapidly with temperature. Thus the efficiency of heat transmission from brickwork to gas, other factors being equal, tends to increase at the higher temperatures of regeneration. Further, the thermal conductivity of a fireclay and a silica product increases with increasing firing treatment. Thus, providing the design and other factors are maintained constant, the efficiency of a regenerator should increase with use. Actually, of course, through slagging, and in some instances actual loss of shape of the firebricks through

overheating, the thermal advantages accruing from industrial usage are not too apparent. The thermal conductivity of silica brick is, on an average, superior to that of a firebrick at high temperature. Consequently there will be a tendency towards extra transmission of heat from the brickwork to the gases in the upper zones of the regenerator during regeneration. This transmission is counterbalanced by a comparative reduction in the temperature gradient.

Materials for Regenerators.

An investigation of the materials supplied for regenerators showed that a great variety of products are used for this purpose. Variations in the degree of burning—some goods were very soft burned, others were exceedingly dense—percentage position ranging from 15 to 28 per cent. after-contraction at cone 14 varying from 0.2 to 2.7 per cent., and marked divergences in structure were noted in these fireclay products. The properties required in the brick are: (1) Non-spalling qualities, (2) structural strength and non-contractile nature, (3) a low porosity and hard-burned structure so far as such are consistent with non-spalling qualities, (4) enhanced thermal characteristics. Starting with a well-conceived texture, with say about 20 per cent. of medium-sized grog, the hard burning of the product will result in increased thermal properties, comparatively low porosity and structural strength. The grog reinforcement will militate against a spalling tendency, while the comparatively low porosity will react against slagging and dust interpenetration.

It is desirable, however, that the material shall not warp or lose shape, owing to contraction taking place during the high temperatures of working. A full knowledge of the firing properties and contractile nature of the clay is therefore necessary in order to ensure that the possibility of volume alteration is reduced to a minimum. Supplementing this knowledge, the behaviour of the product at high temperatures under loads of from 20 to 25 lbs. per sq. in. should be known, as this would also indicate the contractile or viscous properties of the firebrick at working temperatures in the neighbourhood of 1,200 deg. C. It must be thoroughly understood that a fireclay brick is, in the main, a vitrified mass, and, as such, possesses varying degrees of viscosity dependent on temperature. A full appreciation of this would prevent the use of materials which "sag," warp, and in some cases actually fuse. The after-contraction test at 1,410 deg. C. (cone 14) constitutes an efficient guide to the contractile nature of these products. An after-contraction of 0.05 to 0.7 per cent. should not be exceeded.

Observations of steel-furnace regenerators have shown an interesting feature of the effects of dust in the air and the gas chambers respectively. In the gas chamber, the dust has formed slag incrustations on the brickwork, with the consequent reduction in the efficiency of the regenerator. In the air chamber, however, the dust is mainly present as a powder, with no pronounced slagging effects. In other words, it appears that the dust is influenced in its action by the atmosphere. With a consistent reducing atmosphere slagging takes place to a pronounced degree, whereas, with an atmosphere which is periodically very oxidising, such effects are reduced to a minimum, the iron in the dust being in the ferric or magnetic form.

To improve the thermal efficiency of regenerators two more obvious factors may be considered. In the first place, as already mentioned, it is desirable to insulate the bounding walls and thus conserve that heat which soaks through the structure. The second factor is concerned with the improved thermal characteristics of the chequer brickwork. The use of a refractory like carborundum immediately suggests itself. Apart from the economy of the use of such a product, which is naturally a deciding factor, other features of the behaviour of carborundum bricks must be closely observed. It has been shown that this material is prone to (1) oxidation, (2) a swelling with continued use. If these features can be entirely eliminated, then there can be little doubt that increased thermal properties would be very advantageous. At the present, however, the use of carborundum does not appear to be an economical proposition.

Magnetic and Other Changes Concerned in the Temper-Brittleness of Nickel-Chromium Steels.*

By H. A. Dickie, B.Sc., Ph.D., A.R.T.C. (Glasgow).

(*Summary.*)

In a Paper presented to the Institute a year ago, Professor Andrew and the author showed the importance of the rate of cooling from the tempering temperature in revealing changes in specific volume and in hardness in nickel-chromium and other special steels. When the cooling rate was sufficiently slow to induce the fully brittle state in the steels, the specific volume and the Brinell hardness had values similar to those obtained in the same steels quenched from the tempering temperature, that is, in the tough condition. When, however, the rate of cooling was not sufficiently slow to induce brittleness in the steels, a contraction and a softening were revealed by specific volume and hardness determinations. A theory was put forward, based on the above peculiar double effect, to account for the phenomenon of temper-brittleness.

The effect of the experiments was to show that no double effect similar to that obtained in specific volume and in hardness was apparent in the magnetic properties or in the resistivity. The results showed that the magnetic properties were modified by cooling the steels slowly from the tempering temperature, and that the magnetic state of the intermediate condition was similar to that of the brittle condition. These facts, together with a consideration of the manner in which the magnetic properties change on slow cooling, give strong support to the view that temper-brittleness is connected with solution and redeposition of carbide.

The rise in remanence accompanied by a rise in maximum permeability and a small decrease in coercive force and in hysteresis loss are features which would be expected to characterise deposition from solid solution on slow cooling. The fall in resistivity would similarly be expected. Thus, at the tempering temperature, some carbide is held in solution in ferrite, and is retained on quenching from that temperature, but separates out on slow cooling. The double effect in specific volume and in hardness was fully discussed by Professor Andrew and the author in their previous Paper.

The explanation of temper-brittleness, therefore, appears to be, briefly, as follows:—When a steel susceptible to temper-brittleness is cooled slowly from a high tempering temperature, a portion of the carbide, which exists at that temperature in solid solution in the ferrite of the steel, separates out, giving definite modifications of magnetic properties and specific resistance. This also results, at moderate cooling rates, in a contraction and softening, as shown by specific volume and hardness tests. When, however, the rate of cooling is extremely slow, the steel expands and hardens again—relatively to the moderately cooled state—and this is evidently due to the formation of a network of carbide round the grains, producing, by its predominant effect on the coefficient of contraction and its influence in increasing the resistance to penetration, an increase in specific volume and in hardness respectively. Deposition of carbide from solid solution will not, in itself, induce brittleness in the steel. It is only when the rate of cooling is sufficiently slow to allow of expulsion of the carbide to the grain boundaries that brittleness develops.

The author concludes by explaining that since the present Paper was submitted to the Institute he has had the opportunity of perusing a recent publication by Honda and Yamada† on the subject of temper-brittleness. These authors, from tests which include comparisons of the magnetisation and the specific resistance of tough and brittle specimens of susceptible steels, arrive at the conclusion that "temper-brittleness is caused by the carbides separated on the grain boundaries along the solubility line below the A1 point." They express their substantial agreement with the theory and conclusions put forward by Professor Andrew and the author.

* From a Paper read before the Autumn Meeting of the Iron and Steel Institute.

† See "Iron and Coal Trades Review," September 3, 1926.

Random Shots.

So busy has "Marksman" been endeavouring to turn his "Random Shots" into Bulls' Eyes for his readers' benefit, that he has only just awakened to the full glory of our new garb. Truly we begin to feel that at long last we are doing ourselves justice! But, alas! how heavy is the burden that we now bear upon our shoulders—a burden of responsibility imposed by the nature of the surroundings in which we now have to shine! Fortunate is it indeed that even as the guinea-pig has shed its tail and the chameleon has learnt to change its spots in accordance with the dictates of self-interest and self-defence, so, no doubt, will these shoulders of ours, in pursuance of the same beneficent law of nature, become in due course fitted for the tasks imposed upon them!

* * *

It is indeed a fearsome world, and one in which new perils start up daily at our very feet. Think of it—now that the *powers that be* have elected to make a bid for the favour of the *flapper who no longer flaps*, every sweet young thing in knee-length skirts and a shingle becomes a potential elector. Think of it, I say—your secretary, your book-keeper, your very short-hand typist becomes a person of standing and importance, someone to have her favours sought and her fancy won because, forsooth, she has now a vote to bestow. What chance has the poor employer? Ye gods and little fishes, a hard world. . . .

* * *

The announcement that an American firm has designed electrical ovens for core-drying is an admirable illustration of the way in which electrical power is coming to be utilised in founding. The great advantages of the method in this case would appear to be the uniformity of the heat, and the even degree of hardness attained throughout the oven as a consequence thereof. The control is said to be within 3 deg. C., while the time regulator can be set for any length of baking period.

* * *

Modern methods of increasing consumption are illustrated in an interesting fashion by the opening in France and in this country of bureaux of information for nickel and its metallurgical applications. The products of no particular company will be "boosted," but all whom it concerns are well aware that there are only two producers of any importance in this field. Moreover, many will feel that the enlightened way in which they are seeking to promote research, under conditions that are guaranteed to produce results of unquestioned accuracy and complete impartiality, will entitle the producers concerned to the legitimate reward of their far-sighted policy. The whole thing represents the broad rather than the narrow outlook in publicity. In the present case many founders have, after painful experience, doubted the results of American research on nickel in cast iron, and a welcome and timely examination of the whole question is now in progress at the University of Birmingham, with the active co-operation of the Cast Iron Research Association.

* * *

Our efforts for your entertainment are endless. This week we offer you a Translation Competition, which, we are confident, will make a very wide appeal to our readers. All you have to do is to translate into Foundryese the following:—

1. "Be good enough to inform me why you are an hour late in reporting for work this morning?"

2. "It is very disappointing that the core should have become displaced and thus spoiled the casting."

3. "There is some slight risk that unless you remove yourself from your present position with considerable celerity the shank may be upset with disastrous results to all concerned."

It is further suggested that those in need of parlour games to beguile the lunch hour might exchange their answers for purposes of correcting, after the fashion of the children's game of "Consequences."

Marksman.

Institute of British Foundrymen.

SCOTTISH BRANCH.

This section held its first meeting of the session in the Royal Technical College, Glasgow, on Saturday, October 8, when there was a good attendance of members to hear Mr. Thomas Bell deliver his presidential address.

The office-bearers for the new session are:—President, Mr. Thomas Bell; Senior Vice-President, Mr. John Longden; Junior Vice-President, Mr. H. Winterton; Members of Council, Messrs. James M'Arthur, John M'Eachan; R. Kidston, and Alex. Black; Representatives to General Council, Mr. James Affleck, B.Sc., Mr. A. Campion, F.I.C., Mr. J. M. Primrose; Honorary Secretary, Mr. John Bell. The President of the Paisley Section is Mr. George Mackay.

Before entering upon his presidential address Mr. Bell paid a tribute to the work of the honorary secretary, Mr. John Bell. They were very fortunate to have such an untiring worker on behalf of the Institute. The work cost Mr. Bell a great deal of time and energy. He, himself, felt a little despondent when he saw some of the difficulties they were faced with in connection with the syllabus for the session, but the secretary had been able to carry them through.

Presidential Address.

Mr. Bell then delivered his address, in the course of which he said:—

Mr. Affleck and Gentlemen,—The Institute of British Foundrymen, in some respects, is unique. It seeks to gather into its membership all those who, as producers or users of castings, are interested in the advancement of the foundry trade. The problems of the trade are many and varied. There are the problems of metal, ferrous and non-ferrous; the problems of sand, whether as mould or core; the problems of gating, feeding and venting, which, in some respects, are sub-divisions of those already referred to. There are problems of plant, appropriate to the various classes of castings to be made, and there are the related problems of casting design, and how these affect or are affected by the problems I have just enumerated. And there is this other problem: that of finding men possessed of the requisite degree of skill and craftsmanship to co-ordinate all the various factors and produce castings that will be, at once, satisfactory to the buyer and to the seller—sound in structure, good in appearance, and economically profitable.

It may be that I speak from a lack of knowledge of other trades, but it seems to me that in the foundry, the problems are more elusive and the conditions more difficult to stabilise than in, say, the machine shop, the pattern shop, or the forge. I do not wish, in any way, to belittle the difficulties to be met in these branches of engineering, but in each the elements that are uncontrollable, or are, at least, difficult to control seem to be less in number than those to be met on the foundry floor.

Bad Organisers—Good Price Cutters.

The advance of engineering science has gone a long way to overcome some of the earlier difficulties that were met in engineering practice, although the same advance has probably put others as difficult, or more difficult in their place. But the foundry trade has not been keeping pace. We are being asked to produce castings to a more difficult, and a still more difficult specification, and we are not much better equipped for doing so than we were when things were easier. We still have foundries, primitive in layout, in plant, in organisation, trying to produce high-grade castings, and setting the standard, only with respect to price. We have foundries seeking to produce such castings, and yet permitting to exist in their shops conditions which are almost certain to chase away the supply of skilled craftsmanship which alone can produce them.

A Fundamental Service.

It is in a field of such varied nature that the Institute sets itself to work. It recognises the urgent need for the closer co-operation of all the different grades of labour, and for the freer interchange of thought amongst those who would seek to serve the foundry. The employer, the employee: the metallurgist, the moulder; the foundry manager or foreman, and the artisan do not all view any given problem from the same angle, and it is agreed that the more any one of them understands the viewpoint of the others, the more useful a member of the foundry trade will he be.

But in the stress of work-a-day conditions, there is no time for such individuals seeking the others' point of view. And it is just here that the Institute finds its proper field of service. By providing a common meeting ground where the various problems can be discussed, whether in the general or in the particular, it is serving the foundry in a way that cannot be very easily done elsewhere.

And Limitations.

Like all human agencies, it has its limitations. It is not a school where the members present can expect to receive a definite course of instruction on the various problems that are met. Nor can they expect the work of a session to be so co-ordinated that the various meetings will deal with a succession of related problems. The foundry trade being what it is, and the divisions of its work so clear-cut, our work must of necessity be general rather than particular, be diffuse rather than concentrated. On the metallurgical side we have the problems of iron, steel and brass. If we concentrate too much on one we neglect the others. If we try to emphasise the value of metal control, we are in danger of neglecting the particular problems of the craftsman, the materials with which he works, the methods he employs, the tackle he must use. And in this diversity it is not easy to keep a line which will appeal with equal force to all the members. The Institute has its limitations, but it is largely because the field in which it operates is so large, and it, itself, is so small.

It should be remembered, however, that whether we work in the laboratory, or on the foundry floor—or, for that part of it, in the drawing office or in the pattern shop—we are all foundrymen, and every problem we meet—and overcome—will make us more efficient in our calling. And in this Institute this can only be done if the members will each bring their quota to the common pool of experience. No member's experience entirely agrees with that of another. None of our members knows all that is to be known about the foundry, but the combined experience of the branch must be very considerable.

Learning by Service.

The Institute exists to raise the general standard of the foundry, and the status of its members in the foundry. Obviously it can only do so if each member will endeavour to discharge the obligations which rest upon him. The Institute and—in the present case—the Branch possesses a common pool of knowledge in virtue of its membership, and that pool can only be of real service if each member will endeavour to draw from it some experiences which will supplement his own and to contribute to it that experience which is probably peculiar to himself amongst all our members. In other words, I believe that the members who get most value out of our branch are those who contribute most generally to its needs. And the lesson is plain to us all.

It will be urged by some—and, being a practical moulder myself, it is a point I fully appreciate—it will be urged that in the work of self-expression, either in the form of a Paper or in the criticism of another's Paper, the working moulder is at a disadvantage compared with his colleague—trained metallurgical colleague. That may be perfectly true, yet, nevertheless, the working moulder has some experience which would be complementary to the knowledge and experience of the metallurgist if only the latter could get it. And he never can get it until the moulder begins to tell what he knows. Self-expression may be—and probably is—difficult to the average man, but once he has overcome his initial diffidence he will find the difficulty is not so great as it seemed. It has always seemed to me that our silent members could add greatly to the profit of our meetings if only they would summon the necessary courage to rise once in a while and tell us a little of what they know.

There are others of our members whom we never see. It is true that not a few live at a considerable distance from a centre, and many still retain a live connection with their branch although now resident some thousands of miles away. But when every allowance has been made for these, there are still many members who could help us by their presence more than they do. Unfortunately, there is none of them here to-day to hear my suggestion that a more frequent attendance would help us, and them, in many ways. A large meeting is always more encouraging than a small meeting to a speaker—and also to a president. Their presence would have a stimulating effect both on our regular attenders, and also on the visitors whom we are always glad to welcome; and even the foundryman who is still outside our Institute would take more notice of us if he knew our attendance was an increasing quantity.

Since my election to the Presidential Chair, I have been asking myself a number of times what could be done to make our Branch more attractive to foundrymen, both within and without the Institute, and I confess it is difficult to find a satisfactory answer. Recognising that our chief weakness lies in the number of moulders who are content to remain outside our ranks, I wish I could have had the opportunity of speaking *to* them rather than *about* them.

An Appreciation of Long Service.

It is about 18 years since this Branch was formed in Glasgow, and we still have with us some of those who were its founders. As one who has been, more or less, in close touch with its inner working practically since its formation, I feel that we cannot pay too high a tribute to those men, who, by their enthusiasm and untiring devotion, have carried us forward to our present position. Nothing, I think, can be more heartening to the Branch than to know that those pioneers are still keen and active members, and that they are still prepared to go on pioneering as they did nearly a score of years ago.

If only we could get the average moulder to take a fraction of this interest in our work! But this, it would appear, is a quite impossible task. I feel that some of our pioneers would be overjoyed could we succeed in persuading the man on the floor to come even occasionally to some of our meetings. Unfortunately, many of them take such little interest in their work that they are quite unwilling to sacrifice time and energy—not to speak of money—in order to make some progress at their trade. Many of them seem to think they will hear nothing of value at our meetings, and that there is nothing in the trade towards which they can make progress. And I admit that some of them may have some justification for their attitude of indifference, as, on only a very few occasions will a man, in the course of his daily work, be asked to give his opinion on how to make a job or how to run it. But if, after 18 years' experience of the Scottish Branch meetings, I were asked to give my considered opinion, it would be to certify that I, personally, had gained much useful information which I could not readily have got otherwise. I would be able to say, further—and in all sincerity—that in my opinion, no foundryman with the ambition to improve his position in the trade can afford to remain outside our Institute. Many useful hints have been obtained, many happy friendships have been formed, as a result of which vexatious problems have been solved and a greater zest added to the joy of living.

But the difficulty remains. How are we going to get this type of man to our meetings, and how are we going to keep him interested when he

comes? Periodic visits to the various works would help. Most people can be more easily interested by what they see than by what they hear or what they read, and such visits might arouse their interest, and add to their knowledge in a way that nothing else could. I think it would be a great advantage to the Branch if members would submit to the Council any suggestions they may have on this point, or, indeed, on anything affecting the welfare of the Branch. We all know how difficult it is to get the moulder interested, but when we do succeed, there is usually no doubt about his enthusiasm.

The Chance of the Working Moulder.

If we are able to keep step with the allied branches in the engineering industry, we must be prepared for those changes when they come. And yet one cannot regret that the opportunity is now so seldom given to a moulder to display his craftsmanship. The chief element in every job to-day is time. In most foundries, everything is being turned out at a breakneck speed. The system, which is largely adopted by foundry foremen to-day does not lend itself to true craftsmanship, with the result that the moulder often feels that his experience is of no special value—sometimes, not even to himself. So long as he turns out the job in record time, it does not seem to matter what the shape or finish of the casting may be. But occasionally a job comes along in which all the skill and art of the true craftsman is required, and then the most difficult task seems to be to find the right man for the job. For this reason, if or no other, I would say to the ambitious moulder, "If someone is required at the top, why not you? If only a few real craftsmen are required to-day, why not be one of them? There is no reason why the other fellow should beat you in the race." And if he accepts the challenge, I feel certain you will find him in our membership.

It was no uncommon thing in the early days to find the working moulder taking his due share in discussions, and on many occasions expressing a willingness to stake his life on his opinions—although it is just as well he was not always called upon to pay, as he was not always right. It was easy in those days to find a member willing to bring forward a Paper on some practical subject in the foundry, but to-day the position seems very much otherwise. I still think the Institute would be improved with a large addition of working moulders to its membership. Can it be done? How can it be done?

The Position of the Employer.

I have said much about the working moulder. He is at one end of our membership scale, but I would like also to speak for a little concerning the other end of the scale. In Scotland there are still very many firms who should be giving the Institute their support, and who should be included in our membership. Why they are not doing so is more than I can tell. The work of the Institute should appeal to them. They have everything to gain, and they seem, to me, to have nothing to lose.

There is no foundry problem or aspect of foundry work—omitting what is obviously in the nature of research work—on which some light cannot be obtained at our meetings. In our membership, we have eminent metallurgists, foundry managers, engineers, draughtsmen, patternmakers, expert moulders, engaged on all classes of castings. And out of that list, it is easily possible for such firms to get help or advice or suggestions dealing with almost any foundry problem with which they may be faced. In addition, I would remind foundry employers that at our meetings we discuss metallurgical problems, moulding materials, and the various essential processes of the trade. Our members being largely technical rather than commercial are in the foundry trade primarily to make good castings, but realising that their continued existence in the foundry depends on the quality and quantity of the castings they can produce under commercial conditions, they are always alive to the necessity of making progress in every possible direction.

The standard of Papers is rising to a very noticeable degree, and we are being kept well informed with many new and original developments, especially with respect to irons for such high grade castings as Diesel engine and superheated steam work; cupola design and practice; gating and running of moulds; sand, oils, and refractories; as well as mechanical appliances for moulding and general foundry purposes.

Our motto being "Science hand in hand with Labour," we seek to work up to it by making all our members scientific foundrymen. Some one has said that the scientific foundryman is he who applies existing knowledge to the efficient conduct of his work, and that that knowledge may have been gained by past experience, either personal or imparted. Such, I believe, is the type of man this Institute is producing by its work, and by the active co-operation of its members.

The Institute is an organisation of which we may well be proud, and with proper care we may be prouder of it in the future than we have ever been in the past. And as a first step towards a realisation of that hope, I would urge all the members present to do their best to help us increase our membership.

Junior Section.

I feel that I cannot close this address without referring to an interesting occurrence which will take place in the near future under the auspices of the Branch. I refer to the new Junior Section, which it is hoped will then be inaugurated. This question has been before your Council for some considerable time, and while it originated during Mr. Affleck's Presidency, I feel a natural and pardonable pride that it should come into being during my year of office.

In the earlier stages of our consideration of this question, we were seriously concerned regarding the responses we were likely to receive from the boys and young lads in the foundry, and drawing a parallel through our experience of the Branch in recent years, it certainly did not inspire much hope. It was felt that co-operation in some measure with the employers or the management of some of the foundries in launching the section was likely to be of great value to us, and our earlier efforts were largely directed towards exploring that possibility. We had, of course, the inevitable disappointments, and for some time it appeared that the decision would have to be largely a work of faith. We felt—and I think rightly—that it were better not to proceed with the new section at all, than to proceed with it and then have it meet a premature death.

But although we had some grievous disappointments, we had also some encouragements. Some of the employers showed a real live interest in our proposed section, and it is but right to say that but for that interest the section might have been much longer delayed. Their interest was shown in a highly practical manner, and a few of them not only undertook to encourage the boys to join, but also intimated their intention of paying the subscriptions of such of their boys as did join. One firm went even further, and promised to pay their railway fares. In the face of these offers your Council felt they could not very well refuse to go forward with the scheme, and so the sub-committee in charge arranged a meeting at which representatives from some of the firms were present. An opportunity was also taken to discuss the matter with the authorities of the Royal Technical College, and it is perhaps needless to say that they offered every facility they could to help the section.

At the meeting to which I refer four firms sent a representative, and it is but fair, I think, to both the firms and their representatives to say that the atmosphere they brought to our meeting was at once helpful and encouraging. The representatives were men whose position in their respective firms was a guarantee of an intention to help just as much as possible in this venture, and to them, as individuals, I would make this public expression of thanks. Only one of them—Dr. Hyman, of Messrs. Barr & Stroud—is a member of the Institute, the other three being Mr. Longmuir, of Messrs. Mavor and Coulson, Limited, Mr. Milroy of Messrs. Babcock and Wilcox, Limited, and Mr. Packer, of Messrs. G. & J. Weir, Limited.

I would venture to impress upon you the importance of the new section to the Institute and to the foundry trade, and to appeal to you to use your influence on its behalf. Youth is the time for enthusiasm, and if we can capture some of it for our juniors, it will have a wide reaching effect on the Institute proper. The Junior Section should prove a splendid recruiting agency for the Branch, and we hope the boys who join will graduate from it into the Institute, when they reach the appropriate age, not only so, but we hope their enthusiasm may affect us also with much advantage to the Branch.

In this address, Gentlemen, I have attempted simply to show what I think is urgently required to put our Branch into a satisfactory condition. I have endeavoured to strike a note of reasoned optimism because I believe we are about to see a revival of interest in it. But the revival will be more sure if only each of us will rally round the Council and help them in the task which lies before them. As your President for the current session I hope we shall see the progress we desire.

Vote of Thanks.

Mr. Winterton, the Junior Vice-President, moved a vote of thanks to Mr. Bell for his address.

The Secretary announced that the Council had decided to form a Junior Section of the Branch this session. This section will be for apprentices in the foundry, pattern shop, and drawing office, or others under 23 years of age. The movement had met with great success. He was pleased to say that 126 boys had signified their intention of attending the first meeting of the section, and there were more to come. These boys were coming from a very wide area, from Clydebank to Cambusnethan, and from Paisley to Bathgate. Of these 126, not all had agreed to join the Junior Section, but at least 60 of them intended to do so.

The Scottish Junior Section.

Since receiving the above we learn that the new section was inaugurated after a works visit to the establishment of Messrs. G. & J. Weir. No fewer than 400 were provided with refreshments, and at the meeting which followed about 120 signified their intention of joining.

Catalogues Received.

Cast-Iron Houses.—Messrs. Newton, Chambers & Company, Limited, of Thorncliffe Ironworks, near Sheffield, have sent us a copy of their latest pamphlet. It is of an attractive character, and illustrates and describes the Thorncliffe bungalow, which they market for £285, plus £5 for every 50 miles or fraction of fifty miles for transport costs. Foundries contemplating any scheme for the housing of their employees should certainly acquaint themselves with this novel but rational method of construction.

Cast-Iron Pipes.—With their monthly stock list for October, the Staveley Coal & Iron Company, Limited, of Chesterfield, have included a list of cast-iron pipe specials.

Rustproofing.—The Sherardizing Company, of 11, Thames Street, Sunbury-on-Thames, have sent us a 12-page catalogue giving a very full description of the process so widely known as Sherardising. A mistake, in our opinion, has been made in placing the only micrograph on a sort of parchment paper, whilst the illustrations of engineering parts, which have been Sherardised, occupy three pages out of a four-page inset of art paper, the fourth page being left blank. Sherardising, according to this booklet, has recently made some striking developments in application which are of such a character as to warrant the attention of foundrymen, as the rustproofing of cast-iron articles is becoming every year more and more important.

Messrs. Newton, Chambers & Company, Limited, Thorncliffe Centrifugal Casting Department, near Sheffield, have disposed of the rights for France and her Colonies of their centrifugal process as applied to the production of general centrifugal castings to Anciens Etablissements Emile Cochaux, Deville, France. The rights disposed of include only the rights for the application of the process to general castings, and the vendors retain themselves the rights of the application of their process to the production of pipes.

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Trade Talk.

Braithwaite & Company, Limited, of West Bromwich, Newport (Mon.), Calcutta and Bombay, have offered for subscription 150,000 seven-and-a-half per cent. cumulative preference shares.

The partnership heretofore subsisting between M. Manenti and R. Evangelisti, moulders and metal founders, 416, Fulham Road, Fulham, S.W.6, under the style of Garden Crafts, has been dissolved.

Robey & Company, Limited, of Lincoln, have secured orders for two pairs of their drop valve steam winding engines for the North of England. They are two of the largest sizes the firm has constructed, one being a repeat order.

The Staveley Coal and Iron Company, Limited, near Chesterfield, have an order from the Sheffield Corporation Water Department for the supply of about 9,000 tons 36-in. and 30-in. cast-iron pipes, in connection with the Ewden Valley and Moonshine mains extensions.

A company with the name of Holinter, Limited, have been registered to take over the existing business of the Dutch firm, N.V. Hollandsche en Internationale Handel-Mij. Shareholders and management will remain unchanged, while the offices of the new company will be at the same address as before.

A fall of 7s. 4d. in the average net selling price of Cleveland pig-iron for the third quarter of the year reduces, under the sliding-scale arrangement on the North-East Coast, the blast-furnacemen's wages by 7½ per cent. for the last quarter of the year. The average price for the last quarter was 64s. 2d.

The Nova Scotia Supreme Court has granted a stay of execution in order that the Dominion Steel Corporation and British Empire Steel Corporation may appeal to the Privy Council from the judgment of the Supreme Court dismissing their appeal from the winding-up order affecting those companies granted to the National Trust Company.

An order for a steam turbine-driven turbo-blower has been received recently by the English Electric Company, Limited, from Newton, Chambers & Company, Limited, of Sheffield. The blower will be of the company's standard design and capable of delivering varying quantities of air, according to the requirements of the furnace, up to a maximum of 30,000 cub. ft. per minute. It will be coupled to an impulse turbine of 2,300-b.h.p. output.

A third 12,500-kw. "English Electric" turbo-alternator has recently been installed at the Ribble Power Station of the Preston Corporation. This unit is driven by a two-cylinder turbine similar in general design to other machines of this type already built by the English Electric Company, Limited. The impulse high-pressure turbine has a number of relatively small diameter stages and exhausts in to the centre of a double-flow reaction turbine, which in turn is connected to twin condensers in the basement. The installation during the course of next year of a duplicate of the set mentioned above will bring the capacity of the station up to 50,000 kw.

It is stated that the United Steel Companies, Limited, of Workington, have in prospect the re-opening of their Kilton Head Limestone Quarries at Kirkland. The plant is being put in order and the roadways to the quarry face opened up, together with the weighbridge and branch railway, which connects the L.M. & S. main line. The quarry, which has been closed for a considerable number of years, at one time had an output of from 300 to 400 tons per day, and employed a large number of workmen. The company's Rowrah Head Quarries are worked up to the boundary face, and will cease operations shortly, but all workmen concerned will be transferred to Kilton Head, along with others who have been employed there before.

Charles Roberts & Company (1927), Limited, have been formed to acquire as from July 1 last the existing business of wagon builders, etc. The business was founded in 1856. There are offered at par 250,000 six-and-a-half per cent. (free from tax up to 4s. in the £) cumulative preference shares of £1 each in the new company. The works at Horbury Junction, near Wakefield, cover about 36 acres of freehold, while about 40 out-stations, covering 600 points in all parts of the country, are also operated. It is certified that net profits, subject to income-tax, for the past six years averaged £59,142 per annum, which covers the preference dividend requirement nearly three times. Net assets are shown at £544,272 after deducting £67,910 for preliminary expenses and other amounts payable. The purchase consideration is £225,000 in cash and the allotment of 219,400 fully-paid ordinary shares of £1 each. It is stated that the works are at present engaged to their full capacity. The new company assumes responsibility for debentures of the old company to the amount of £119,937, which carry interest at an average rate of 6 per cent. and may be redeemed by the company at any time.

The Electricity Commissioners have prepared a scheme for the co-ordination of electrical development throughout the whole of South-East England. The scheme, which has been transmitted to the Central Electricity Board for adoption, has just been issued and will remain before the public for six weeks. The new scheme deals with the area embracing the counties of London, Middlesex, Essex, Kent, Surrey, Berkshire, Buckinghamshire, Bedfordshire, Cambridgeshire, Huntingdonshire, and parts of the counties of Sussex, Hampshire, and Suffolk. It is an area of about 8,828 square miles in extent and stretches from Wisbech and Peterborough, in the North, to the South Coast. The population affected—according to the last census—is 11,392,361. Under the proposals, 13 existing stations and the two new stations projected at Battersea and Chiswick will be selected and operated by the Board. The existing selected stations are: Bankside (City of London Electric Lighting Company, Limited), Barking (County of London Electric Supply Company, Limited), Bow (London Power Company, Limited), Brighton (Brighton Corporation), Brimsdown (New) (North Metropolitan Power Station Company, Limited), Deptford East (London Power Company, Limited), Deptford West (London Power Company, Limited), Grove Road (London Power Company, Limited), Hackney (Hackney Borough Council), Peterborough (Peterborough Corporation), Stepney (Stepney Borough Council), West Ham (West Ham Corporation), and Willesden (London Power Company, Limited).

The need for co-operation in the ironfoundry industry was expressed at the opening meeting of the session of the East Midlands Branch of the Institute of British Foundrymen held recently at the Loughborough College. Immense progress has been made, Mr. H. Pemberton, of Derby, pointed out in his presidential address, during recent years in developing die casting in various metals, but by standardising much greater scope would be extended in the modern methods by which thousands of tons of metal were being saved through the abolition of machine work. They must concentrate their thoughts on accuracy with a minimum of machine work, and it was in this direction that the foundry would and must establish itself as a dominating factor in the engineering world. The present practice of buying costly machines would, he hoped, be displaced by installing equipment in the foundry which would be capable of producing castings, if not actually finished, with the minimum of further operations. "If we are to increase our trade," proceeded Mr. Pemberton, "we must increase our production, and to do this something more is required than the adoption of machinery—there must be amalgamation, standardisation and co-operation." It was not impossible, he thought, that the future would see cast iron melted by means of electrical power, at a less cost, and of better quality. It was possible that a metal might one day be evolved which would embrace all the features of the metal at present commonly used. He thought an instrument was possible on the principle of the X-ray, which would enable them to see what was actually going on inside the mould during casting operations.

Sir Alfred Mond, chairman of Imperial Chemical Industries, has announced a comprehensive co-partnership scheme which is to be put into operation very shortly. The scheme provides *inter alia* for the extension of the period of notice given to certain employees, the purchase of shares in the company on preferential terms, the presentation of free shares in proportion to purchases, the creation of a special "staff grade," and the setting up of three types of Works Council and a "Central Labour Department." Sir Alfred Mond is of opinion that industry cannot be improved by making the rich poorer, and that it can only be done by making the poor richer. One must not destroy the capitalist, but must turn the workman himself into a capitalist. The principal points of the company's new labour programme are as under:—(1) A central Labour Department has been established to deal with all questions affecting the relations between the company and its employees throughout all the works in the Combine. It will be administered by specialists, and will have the assistance of an advisory committee. (2) Works councils will be set up in all the works. These works councils, which will be of three forms—local, general and central—will provide direct links between the board and the workers in the remotest works, and will be representative equally of the management and of the workers. (3) Staff grade of workers is to be established for the purpose of giving the best workers a greater economic security and a higher status. All men of five years' service and over will be eligible for promotion to the staff by the directors. It is contemplated that up to 50 per cent. of the men eligible may be promoted. Those concerned will be paid a weekly wage instead of an hourly rate, and will receive the following addition:—(*a*) A month's notice of termination of employment; (*b*) payment of wages for Bank holidays even if not worked; (*c*) payment of full wages (less National Health Insurance benefit) for all certified sick absence up to six months in any year. (4) For the purpose of encouraging all ranks of workers to obtain a direct financial interest in the company, a comprehensive workers' shareholding scheme is to be applied. Under this scheme the worker may at any time purchase ordinary shares in the company at 2s. 6d. below the mean market price. Moreover, free shares will be presented on a scale ranging from one free share for every four shares bought by workers receiving £200 a year or less to one free share for every eight shares bought by workers earning between £1,500 and £2,000. If the worker should die before completing his payments (which may be by instalments), the company will take over his obligations and hand the share fully paid to his next-of-kin. The scheme is intended as an investment scheme; and, while no absolute restriction is placed upon the workers, they will not be expected to speculate with their shares, and the directors reserve the right to refuse to allot further shares to a worker who does not enter into the spirit of the proposal.

Obituary.

The death has occurred at Stanmore, Northam, North Devon, at the age of 72, of Mr. Edwin George Tardrew, head of the well-known foundry firm at Bideford, Tardrew & Sons, which was established by his father, Mr. Henry Tardrew.

The death occurred on October 6 at the Great Northern Hospital of Mr. Wm. Henry Anstice, secretary of the London Iron & Steel Exchange Company, Limited, 123, Cannon Street, at the age of 34. He was the London partner of Walter Meacock & Company, Limited, chartered accountants, of London and Newport, Mon.

Mr. Joseph Broadbent, manager and director of R. Broadbent & Sons, Limited, Phœnix Iron Works, Stalybridge, was fatally injured in the hoist shaft at the works. Mr. Broadbent was 79 years of age, and had been connected with the firm for 55 years. He was found at the bottom of the hoist shaft with his shoulders trapped under it, and his head in the well. The hoist, which was in perfect running order, was sent down for him from the top landing a few minutes before. At the inquest the Factory Inspector said he could throw no light on the accident, and a verdict of accidental death was returned.

The death has occurred suddenly at the age of 62 of Mr. Barnett Cohen, vice-chairman of George Cohen, Son & Company, Limited, iron and metal merchants, 600, Commercial Road, E.14. He will be sadly missed by a host of friends, both in business, where his advice and ripe experience were so much valued by his co-directors, as well as in the social world where he was very popular. His business activities included that of chairman of the Shipbreaking Company, Limited, Briton Ferry, South Wales, and other associated companies. Mr. Barnett Cohen was the second surviving son of the late Mr. George Cohen, founder of the firm.

Personal.

Sir Alfred Yarrow, who is 86, has resigned his position as president of the shipbuilding and engineering firm of Yarrow & Company, Limited, Glasgow.

Mr. Alfred Cartwright has resigned his seat on the board of Vickers, Limited. General Sir Noel Birch and Mr. G. G. Sim, the secretary of the company, have been elected directors.

Sir William James Larke, K.B.E., has been appointed by Order of Council to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

Mr. Jno. R. Hyde, managing director of Messrs. Robert Hyde & Company, Limited, of Sheffield and Chesterfield, has been elected a member of the Council of the Institute of British Foundrymen to fill the vacancy caused by the election of Mr. Wesley Lambert as a vice-president.

Wills.

Armstrong, J., works manager at the North-Eastern Steel Works of Dorman, Long & Company, Limited	£2,964
Gray, G., of Murrayville, Flower-and-Mill Hill, N.W., a director of J. Wontner-Smith, Gray & Company, Limited ...	£9,627
Sperring, B. F., of Lake Road, Landport, Portsmouth, of William Henry Sperring & Company, Limited, Albion Iron Works, Landport	£9,003

"SERVICE GRC FIRST"

A WARNING NOTE!

"RAMMED CUPOLA LININGS"

¶ From the earliest Ages there have been Medicine Men and Witch Doctors who, with much clamour and beating of tom-toms, have endeavoured to obscure the simplest processes with a smoke-screen of self-interest. They have tried to set back the clock of progress so that they, and they alone, might perform certain acts and thus be able to exact tribute from the other members of the tribe.

"SEND FOR US," they have wailed (often crudely and not in the best of taste), "we are positively the only people who know anything about "it, for have we not done it with our own lily-white hands for the last "half century? Look at the dust in our eyes! Look at the clay in our "hair! That's practical experience, and please Mr. Foundryman, don't "let anybody make you think you are clever enough to ram a cupola "without outside help."

DO NOT BE MISLED

into supposing that there is any great difficulty in ramming a cupola with the very best material obtainable.

It may be hard to ram it with certain preparations, and necessary to have them applied by the firms who supply them, but any man with intelligence enough to run a Foundry can easily ram a Cupola with

STANDARD RAMMING GANISTER

Requires no venting - Easily applied - Ready for instant use
Durable - Reliable and not expensive.

Hundreds of Crucible Steel Furnaces have been rammed with similar ganister for the last fifty years, and have stood for a month without repair.

Further details, information and instructions will be supplied with pleasure on application to:

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Iron and Steel Markets.

Pig-iron.

MIDDLESBROUGH.—The welcome revival of the shipbuilding industry on Tees-side and elsewhere, heavy tonnages having already been secured by local builders, has had a further stimulating effect in restoring activity in the Cleveland iron trade, and the outlook may now be considered far more hopeful than has been experienced for many months past. A much more confident tone is consequently expressed in market circles, consumers appearing to be convinced that prices are not likely to fall any further, and the definite orders for new ships providing just the sort of stimulus that was needed to set things going. Further encouragement of this view of the position is provided in the fact that Cleveland furnaces are now well sold for prompt and forward iron, although foreign trade is still retarded by the competitive prices quoted by Continental makers. Taken as a whole, therefore, the position is much more favourable, and if it has not yet been found necessary to increase output, there are prospects that this step will not be much longer delayed. Prices continue very firm, home consumers' quotations ruling:—No. 1 Cleveland foundry iron, 70s. per ton; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton. All these prices are subject to a discount of 2s. 6d. per ton on sales to Scotland or abroad. The officially ascertained average realised price of No. 3 G.M.B. pig-iron for the quarter ended September 30 was 67s. 2.43d. per ton, compared with 74s. 6.61d. per ton for the previous quarter.

Business in the Tees-side hematite market continues subject to keen competition, with the result that makers are not disposed to decline any reasonable offer, more particularly for export orders, for which some very low prices have been accepted. Up to 74s. per ton has been paid recently for East Coast mixed numbers, but an average price is not more than 73s. per ton, and No. 1 is put at 6d. per ton premium. On the North-West Coast, prices are unaltered, Bessemer mixed numbers being still quoted at 73s. to 74s. per ton at works.

LANCASHIRE.—Conditions in the local market for foundry pig maintain the slight improvement recently noted. Derbyshire and Staffordshire furnaces reporting satisfactory bookings compared with the experience of a few weeks ago. Regarding prices, Derbyshire No. 3 foundry can still be purchased at rather lower than 74s. per ton, Staffordshire makes at about 73s. 9d. per ton, while Cleveland and Scottish irons have only been in moderate demand at 80s. 8d. and 89s. 6d. per ton respectively, all for delivery Manchester or equal.

THE MIDLANDS.—It is satisfactory to note that more consumers have come into the market of late to cover requirements until the end of the year, this being the first time this year that ironfounders generally have committed themselves to forward supplies. Cleveland pig-iron is unaltered in price at 83s. 3d. for No. 3, and Lincolnshire No. 3 is offered at 80s. per ton delivered, while Scotch No. 3 foundry pig-iron is about 92s. 6d. delivered.

SCOTLAND.—Only a moderate demand for foundry quality iron can be reported in the Scotch markets, with the current quotation slightly easier at 73s. for Eglinton brands at furnaces. Here and there buyers are to be found who are inclined to look ahead for their requirements, but, generally speaking, the business being done is for prompt delivery. Founders generally are very quiet.

Finished Iron.

The recently announced reduction in the price of Staffordshire marked bars to £13 basis has not yet had any great effect on the volume of orders coming through. Business in this class of bar is only just moderate. These conditions also apply in respect to crown and cheaper grades of bars. Small orders are eagerly sought by the makers, and any price from £9 10s. delivered South Staffordshire area is quoted for "Crown" grade, although the genuine brands are quoted nearer £10 5s. The Lancashire and Derbyshire makers are quoting very low prices in the Midlands. Owing largely to foreign competition, little business is possible for nut and bolt iron, the local price of which is about £9, whereas the Belgian material is offered freely at £5 15s. delivered Darlaston district.

Steel.

Quite recently a somewhat more encouraging view of the situation of the steel industry has found expression in market circles, although, so far as Sheffield is concerned, actual business shows little improvement. There is, however, rather more doing in acid steel billets. Basic billet business is, if anything, somewhat smaller, and Continental competition continues to be severely felt. Prices:—Siemens acid, £10; soft basic, £7; semi-hard, £7 10s.; medium, £7 12s. 6d.; hard, £8 2s. 6d., all per ton delivered. In the cheaper classes of steel the volume of business is smaller, but makers of special steels are doing much better. There is a sound business in steel sheets. Wire rod orders have fallen away. The tinplate market continues in a very quiet condition, and the demand is far from satisfactory. The inquiry is larger, but business is slow in maturing. Many mills are idle, and the demand must improve considerably before a restart can be made.

Scrap.

The general depression in the various markets for scrap metals noted in recent reports continues unabated, and in some districts has reached the stage of complete stagnation. An exception to the general rule may, however, be claimed for the South Staffordshire area, where the demand for cast-iron scrap, for use in the local foundries, has been well maintained. Prices, however, are very varied. For heavy machinery scrap in cupola sizes 72s. 6d. per ton delivered is the average price. There is not such a good demand for the lighter qualities at 55s. per ton delivered. Cast-iron borings are firm at 28s. 6d. per ton f.o.t. In Scotland, machinery cast-iron scrap remains unchanged around 67s. 6d. to 68s. 6d. per ton, for pieces suitable for foundries and not exceeding 1 cwt., ordinary heavy cast, to the same specification, being 5s. per ton less. Old cast-iron railway chairs have been done recently at 67s. 6d. per ton, and for light cast iron and firebars 55s. to 56s. 3d. per ton. These prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—After a lengthy period of depression, the base metal markets towards the close of the week experienced a sharp reaction to higher values, standard copper advancing to just over £55 cash, as contrasted with recent low levels. The most encouraging feature at the moment, from the producers' point of view, is the increased consumption of copper in Germany. A movement is also now afoot among manufacturers of copper goods in this country, to establish an organisation for promoting the use of all descriptions of copper and brass products, on similar lines to the Copper and Brass Research Association in the United States.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £55 1s. 3d. to £55 2s. 6d.; Friday, £55 15s. to £55 16s. 3d.; Monday, £55 1s. 3d. to £55 2s. 6d.; Tuesday, £55 to £55 1s. 3d.; Wednesday, £55 11s. 3d. to £55 12s. 6d.

Three Months: Thursday, £55 3s. 9d. to £55 6s. 3d.; Friday, £55 15s. to £55 16s. 3d.; Monday, £55 2s. 6d. to £55 3s. 9d.; Tuesday, £55 1s. 3d. to £55 3s. 9d.; Wednesday, £55 11s. 3d. to £55 12s. 6d.

Tin.—A similar movement to that above recorded was also marked in standard tin, values appreciating at the week-end to no less than £265 5s. per ton, an advance of upwards of £5 on the previous day's quotations. The recovery was due to more favourable advices from America and the East, while the statistics for September were not quite so bad as had been apprehended, in spite of the Straits shipments turning out much in excess of recent estimates, their total being as much as 8,393 tons, of which nearly 5,000 tons went to the United States.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £259 10s. to £259 15s.; Friday, £265 to £265 10s.; Monday, £262 7s. 6d. to £262 10s.; Tuesday, £261 15s. to £261 17s. 6d.; Wednesday, £265 5s. to £265 10s.

Three Months: Thursday, £258 to £258 5s.; Friday, £262 to £262 5s.; Monday, £259 10s. to £259 15s.; Tuesday, £258 12s. 6d. to £258 15s.; Wednesday, £261 17s. 6d. to £262.

Spelter.—Prices of ordinary spelter, too, suggested the probability of an upward turn at an early date, although the immediate future is puzzling, and the course of future values must be looked for in the States. The exact position on the Continent is obscure, and probably stocks on the whole are increasing; but, as previously stated, they are strongly held and are not being pressed on the market.

The following are the week's prices:—

Ordinary: Thursday, £27 11s. 3d.; Friday, £27 10s.; Monday, £27 5s.; Tuesday, £27 5s.; Wednesday, £27 5s.

Lead.—The demand for soft foreign pig of late has been well maintained, and a fair amount of buying has been done by consumers here and on the Continent. Fluctuations in price have been irregular, and until there is some definite news that the leading producers have decided to curtail production, no sustained upward tendency can be anticipated.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £20 17s. 6d.; Friday, £21 1s. 3d.; Monday, £21 1s. 3d.; Tuesday, £20 15s.; Wednesday, £20 16s. 3d.

Contracts Open.

Dublin, October 26.—100 pairs of finished wagon cast-steel solid spoke wheel centres, complete with axles and tyres, for the Great Southern Railways, Ireland. The Company's Stores Superintendent, Inchicore, Dublin. (Fee 2s. 6d.)

Billinghay, etc., Lincs, October 31.—Iron frontage fence, for the Sleaford Rural District Council. Mr. E. H. Sills,, Northgate, Sleaford.

Johannesburg, November 17.—130 wagon bogies, for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,291.)

London, S.E.1, October 25.—2,000 cast-iron pipes, specials and valves with victualic joints, for the India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 5s. per set, non-returnable.)

Plymouth, October 27.—6,000 yds. 4-in. cast-iron pipes, British Standard, Class D, for the Plymouth Corporation Waterworks. The Town Clerk, Municipal Buildings, Plymouth.

Wellington, N.Z., January 12.—(E. 53) One 2-ton capstan; (E.53) one 1½-ton capstan; (E.54) one 2-ton battery crane truck; (176) motor; (176A) two motor-driven air compressors, for the New Zealand Government Railway Department. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,254.)

Johannesburg, November 10.—Stone-crushing plant, including conveyor belt, endless rope haulage, and electric motors, etc., for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,263.)

Company Reports.

Thomas Smith's Stamping Works, Limited.—Profit, £25,147; final dividend, 7½ per cent., less tax, making total for year 10 per cent.; balance, £22,823, carried forward.

Tinsley Rolling Mills Company, Limited.—Loss, £1,573; dividends on preference to June 30, 1927, £2,100; brought forward, £3,392; credit balance, £4,718, carried forward.

George Turton, Platts & Company, Limited.—Profit, £20,417; brought in, £6,927; total, £27,344; dividends on preference shares, £1,935; ordinary dividend, 8 per cent., less tax; transfer to reserve fund, £5,000; carry forward, £10,849.

New Companies.

Engine Power, Limited, 7, Grosvenor Gardens, S.W.1.—Capital £150 in 1s. shares. To acquire stock of engines and other engineering material now in possession and owned by G. Constantinesco, at premises at the Slough Trading Estate, Slough, Bucks. Permanent directors, G. Constantinesco and A. Kitson.

Malcolm Owen, Limited.—Capital £2,000. Dealers in metals, etc. Permanent governing director, M. Owen, 16, Leslie Road, East Finchley, N.2.

S. Tyzack & Son, Limited, 341, 343 and 345, Old Street, Shoreditch, E.—Capital £20,000 in £1 shares. Tool dealers.

Sterling

BOXES

STAND UP TO THEIR WORK BECAUSE THEY ARE MADE FROM

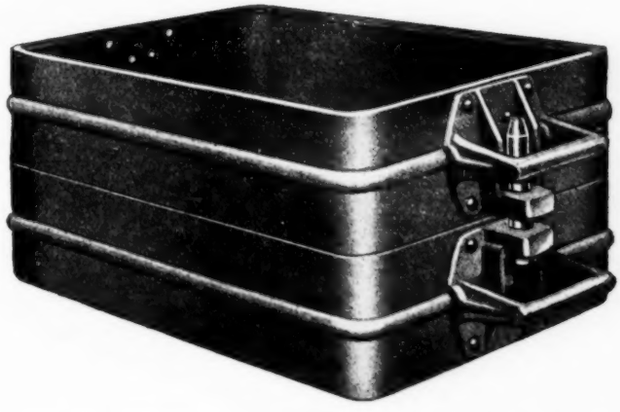
ROLLED STEEL

THEY ARE LIGHT AND EASY TO HANDLE, STRONG, RIGID AND PERMANENTLY ACCURATE.

There is no greater economy you can introduce into your foundry than the

Sterling Rolled Steel Moulding Box

LET YOUR NEXT LOT OF BOXES BE "STERLINGS."



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Code: WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	55	11	3
Three months	55	11	3
Electrolytic	62	10	0
Tough	60	15	0
Best selected	61	15	0
Sheets	86	0	0
India	71	10	0
Wire bars	62	15	0
Do. November	62	10	0
Do. December	62	10	0
Ingot bars	62	10	0
H.C. Wire rods	67	2	6
Off. av. cash, Sept.	54	9	9 3/11
Do. 3 mths., Sept.	54	19	0 3/11
Do., Sttlmnt., Sept.	54	9	9 3/11
Do., Electro, Sept.	62	0	2 3/11
Do., B.S., Sept.	60	11	11¼
Aver. spot price, copper, Sept.	54	9	9¼
Do., Wire bars, Sept.	62	3	10½
Solid drawn tubes			12¼d.
Brazed tubes			12½d.
Wire			9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	9½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	265	5	0
Three months	261	17	6
English	265	0	0
Bars	263	5	0
Straits	268	5	0
Australian	266	15	0
Eastern	262	5	0
Banca	272	15	0
Off. av. cash, Sept.	280	10	10 3/22
Do., 3 mths., Sept.	276	6	2 3/22
Do., Sttlmt., Sept.	280	10	5 3/11
Aver. spot, Sept.	280	10	10¼

SPELTER.

	£	s.	d.
Ordinary	27	5	0
Remelted	25	12	6
Hard	21	10	0
Electro 99.9	30	17	6
English	27	15	0
India	23	10	0
Zinc dust	35	0	0
Zinc ashes	9	0	0
Off. aver., Sept.	27	6	8 15/44
Aver., spot, Sept.	27	6	11¼

LEAD.

	£	s.	d.
Soft foreign ppt.	20	16	3
English	22	0	0
Off. average, Sept.	21	14	4 27/44
Average spot, Sept.	21	8	11

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	36	0	0
Do. V.M. ex whf.	34	10	0
Rods	42	0	0
Boiler plates	34	0	0
Battery plates	33	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	64	10	0
Chinese	44	10	0
Crude	37	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%..	8	17	6
45/50%	12	15	0
75%..	20	0	0
Ferro-vanadium—			
35/40%	14/3 lb. va.		
Ferro-molybdenum—			
70/75% c. free	5/- lb.		
Ferro-titanium—			
23/25% carbonless	11½d.		
Ferro-phosphorus, 20/25%	£17	15	0
Ferro-tungsten—			
80/85% c. fr.	1/3 lb.		
Tungsten metal powder—			
98/99%	1/8 lb.		
Ferro-chrome—			
2/4% car.	£33	0	0
4/6% car.	£23	0	0
6/8% car.	£22	17	6
8/10% car.	£22	10	0
Ferro-chrome—			
Max. 2% car.	£35	17	6
Max. 1% car	£41	10	0
Max. 0.70% car	£53	0	0
70% carbonless	1/4 lb.		
Nickel—99% cubes or pellets	£170	0	0
Ferro-cobalt	9/3 lb.		
Aluminium 98/99%	£105	0	0
Metallic chromium—			
96/98%	3/- lb.		
Ferro-manganese (net)—			
76/80%, loose	£13	0	0
76/80%, packed	£14	0	0
76/80%, export	£11	15	0
Metallic manganese—			
94/96% carbonless	1/10 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	£	s.	d.
Finished bars, 14% tungsten	£0	2	6
Finished bars, 18% tungsten	£0	3	0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—			
Hvy. steel	3	0	0
Bundled steel and shrngs.	2	12	6
Mixed iron and steel	2 11 0 to	2	12 6
Heavy cast iron	2	17	6
Good machinery for foundries	3	2	6
Cleveland—			
Heavy steel	2	17	6
Steel turnings	2	5	0
Cast iron borings	2	2	6
Heavy forge	3	12	6
Bushelled scrap	3	2	6
Cast-iron scrap	3 1 0 to	3	5 0
Lancashire—			
Cast-iron scrap	3	5	0
Hvy. wrought	3	2	6
Steel turnings	2	2	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	48	0	0
Brass (clean)	37	0	0
Lead (less usual draft)	18	0	0
Tea lead	15	10	0
Zinc	16	10	0
New aluminium cuttings	76	0	0
Braziery copper	45	0	0
Gunmetal	46	0	0
Hollow pewter	170	0	0
Shaped black pewter	130	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	73/6
Hematite M/Nos.	73/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
,, d/d Birm.	92/6
Midlands—	
Staffs. common*	—
,, No. 4 forge	—
,, No. 3 fdry.	65/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	54/-
,, fdry. No. 3	60/6
Derbyshire forge	60/-
,, fdry. No. 3	65/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	73/-
Hem. M/Nos.	76/-
Sheffield (d/d district)—	
Derby forge	60/-
,, fdry. No. 3	65/-
Lincs. forge	—
,, fdry. No. 3	68/-
E.C. hematite	85/-
W.C. hematite	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	73/-
Northants foundry No. 3	—
Dalzell, No. 3	105/- to 107/6
Summerlee, No. 3	90/- to 100/-
Glengarnock, No. 3	90/- to 100/-
Gartsherrie, No. 3	90/- to 100/-
Monkland, No. 3	90/- to 100/-
Coltness, No. 3	90/- to 100/-
Shotts, No. 3	90/- to 100/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.	9	15	0 to	10	15	0
Angles				—		
Tees to 3 united ins.				—		
Nut and bolt iron				—		
Hoops				14	10	0
Marked bars (Staffs.) f.o.t.				13	0	0
Gas strip				12	10	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates				8	2	6
Boiler plts.				10	10	0
Chequer plts.				10	5	0
Angles				7	12	6
Tees				8	12	6
Joists				7	12	6
Rounds and squares, 3 in. to 5½ in.				7	15	0
Rounds under 3 in. to ⅜ in. (Untested)				8	0	0
				and upwards		
Flats, over 5 in. wide and up				9	2	6
Flats, 5 in. to 1½ in.				8	2	6
Rails, heavy				8	2	6
Fishplates				12	10	0
Hoops (Staffs.)				10	10	0
Black sheets, 24g.				10	12	6
Galv. cor. shts., 24g.				13	17	6
Galv. fencing wire 8g. plain				12	10	0
Billets, soft	£5	15	0 to	7	0	0
Billets, hard				8	2	6
Sheet bars	£5	12	6 to	5	15	0
Tin bars	£5	12	6 to	5	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 2⅝
Wire	1 3¼
Rods	1 2⅝
Tubes	1 8
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3¼ to 1/9¼
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	17.25
Basic	20.00
Bessemer	19.76
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Phila.	2.07
Steel bars	1.75
Tank plates	1.75
Beams, etc.	1.75
Skelp, grooved steel	1.75
Skelp, sheared steel	1.75
Steel hoops	2.30
Sheets, black, No. 24	3.00
Sheets, galv., No. 24	3.85
Sheets, blue an'l'd., 9 and 10	2.15
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.25
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	18/-
,,	28×20	,,	36/-
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	17/3
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—

Terneplates 28×20 — per box basis f.o.b.

SWEDISH IRON.

Bars, hammered, £18 10 0 to	19 0 0
Rolled Ord. £15 0 0 to	£15 10 0
Nail rods £15 7 6 to	£15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron £5 15 0 to	£6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	45%
Water	63¾%	40%
Steam	60%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Oct. 13		55	1	3	inc. 6/3
,, 14		55	15	0	,, 13/9
,, 17		55	1	3	dec. 13/9
,, 18		55	0	0	,, 1/3
,, 19		55	11	3	inc. 11/3

Electrolytic Copper.

		£	s.	d.	
Oct. 13		62	5	0	No change
,, 14		62	5	0	,, ,,
,, 17		62	5	0	,, ,,
,, 18		62	5	0	,, ,,
,, 19		62	10	0	inc. 5/-

Standard Tin (cash).

		£	s.	d.	
Oct. 13		259	10	0	dec. 45/-
,, 14		265	0	0	inc. 110/-
,, 17		262	7	6	dec. 52/6
,, 18		261	15	0	,, 12/6
,, 19		265	5	0	inc. 70/-

Tin (English ingots).

		£	s.	d.	
Oct. 13		259	0	0	dec. 45/-
,, 14		264	15	0	inc. 115/-
,, 17		262	0	0	dec. 55/-
,, 18		261	5	0	,, 15/-
,, 19		265	0	0	inc. 75/-

Zinc Sheets (English).

		£	s.	d.	
Oct. 13		36	0	0	No change
,, 14		36	0	0	,, ,,
,, 17		36	0	0	,, ,,
,, 18		36	0	0	,, ,,
,, 19		36	0	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
Oct. 13		27	11	3	inc. 3/9
,, 14		27	10	0	dec. 1/3
,, 17		27	5	0	,, 5/-
,, 18		27	5	0	No change
,, 19		27	5	0	,, ,,

Lead (English).

		£	s.	d.	
Oct. 13		22	5	0	inc. 10/-
,, 14		22	5	0	No change
,, 17		22	5	0	,, ,,
,, 18		22	0	0	dec. 5/-
,, 19		22	0	0	No change

Exports of Iron Castings in September and the nine months 1927, compared with September and the nine months 1926.

	September, 1926.	September, 1927.	Nine months, 1926.	Nine months, 1927.	September, 1926.	September, 1927.	Nine months, 1926.	Nine months, 1927.
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
To Argentine Republic	160	152	1,088	1,211	5,693	6,354	45,079	45,763
,, British South Africa	349	236	3,261	2,052	11,624	9,422	110,755	75,019
,, ,, East Indies	177	115	1,349	1,243	7,083	6,811	58,789	59,282
,, Australia	64	61	656	714	4,013	3,770	36,846	41,002
,, New Zealand	222	178	1,761	1,556	11,522	8,553	85,840	78,519
,, Other countries	712	875	6,039	5,704	37,649	40,551	291,483	285,115
Total	1,684	1,617	14,154	12,480	77,584	75,461	628,792	584,700
PIPES AND FITTINGS—CAST—								
To Argentine Republic	1,011	415	6,628	6,944	11,089	4,826	80,713	76,732
,, British South Africa	345	1,025	5,773	8,593	7,294	10,888	80,264	101,998
,, ,, India	411	347	6,461	5,061	7,178	4,487	83,496	78,859
,, Straits Settlements and Malay States	785	1,611	13,511	11,586	8,491	14,511	116,202	113,071
,, Ceylon	32	96	1,561	1,125	519	967	17,812	13,129
,, Australia	59	727	3,092	6,871	2,384	8,739	42,454	81,304
,, Other countries	2,307	5,717	35,677	46,127	38,165	71,655	498,423	603,205
Total	4,950	9,938	72,703	86,307	75,120	116,073	919,364	1,068,298
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	459	446	4,982	3,480	14,842	18,381	174,161	137,488
,, Enamelled	105	60	740	525	12,267	6,917	79,190	53,931
CASTINGS, in the rough—								
Iron	56	121	1,108	909	1,993	4,033	31,200	32,743
Steel	26	137	549	729	1,369	6,099	16,736	33,787

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
ROYAL BLDS., FISHER ST., SWANSEA.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
20, SECOND LINE BEACH, MADRAS.
1, HONG KONG ROAD, SHANGHAI.

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OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON
NADIR HOUSE, MACLEOD ROAD, KARACHI.
1 SHAREH SONK EL TEWFIKIEH, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD MIDDLESBROUGH

SMALL ADVERTISEMENTS.

SITUATIONS VACANT AND WANTED.

FOUNDRY MANAGER OR FOREMAN.—Wanted, a position in Heavy and Light Engineering or General Jobbing; loam, dry sand, green sand, plate and machine moulding; 20 years' experience; highest references; mixing of metals; member of I.B.F.—Box 438, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER, twenty years' experience, desires post; thoroughly conversant with up-to-date Foundry practice; good references; would consider post as Representative of first-class foundry requisite and equipment manufacturers.—Please state terms and territory. Box 466. Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

LADY CLERK, shorthand, typing, business routine, publicity, thoroughly conversant with Foundry terms, desires change.—Box "F. C. H.," Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MEMBER, Chartered Secretaries (37), desires Secretaryship or Accountant, Colliery or Coal Factors; keen, energetic, accustomed responsibility, staff control; references; present appointment Assistant Accountant reputable company.—Box 470, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

YOUNG MAN (23) seeks position as Assistant to Foundry Manager, or any position of trust, with a firm of Engineering Ironfounders; six years' first-class practical and metallurgical training; highest references.—Box 464, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN, young and energetic, wanted for up-to-date Foundry, knowledge of chill casting, stoving and power press work essential; must be good organiser.—Box 472, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN.—Wanted for a Modern Foundry, a first-class practical Moulder, with a knowledge of Marine and Diesel Castings of all weights; must be capable of estimating and fixing piecework prices; only those with experience as Foreman need apply.—Apply, stating experience, with reference and wages required, "Foundry," Wm. Porteous & Company, Advertising Agents, Glasgow.

AGENCIES.

MERCHANT FIRM, having well-appointed Offices in Westminster, with qualified Secretarial and Technical Staff and Overseas Shipping connection, is prepared to act as London and/or Export Agents for a manufacturing firm.—Write, "T. J.," c/o J. W. Vickers & Company, Limited, 24, Austin Friars, E.C.2.

IMPORTANT Czechoslovak firm wants Agency of British Steel Works (good mark essential).—Offers to F. Wiesner, 30, Streatham Place, London, S.W.2.

PATENTS AND TRADE MARKS.

INFORMATION HANDBOOKS, Advice, and Cons. free; King's Patent Agency, Ltd.—B. T. King, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146a, Queen Victoria Street, E.C.4. 40 years' refs. 'Phone: 0682 Central.

PROPERTY.

FOR SALE.

THE VALUABLE AND EXTENSIVE WORKS, SITE AND BUILDINGS,

Formerly used by J. Crowley & Company, Ltd.

AT MEADOW HALL, SHEFFIELD.

RAILWAY SIDINGS to L.M.S. and L.N.E. Rlys. Area about 11 acres, FREEHOLD. Works well situated and compact. Floor space about 145,000 sq. ft.

Full particulars and terms furnished on application.

THOS. W. WARD, LTD.
ALBION WORKS, SHEFFIELD.

PROPERTY.—*Continued.*

FOR SALE AS A GOING CONCERN.

Offers are invited for

A LARGE BUSINESS OF STEEL FOUNDERS AND ENGINEERS,

situated near London.

The Works cover a large area, are Modern and Well Equipped, and have extensive Railway Sidings.

Full particulars can be obtained from:—

A. E. Tilley, F.C.A.,
8, Staple Inn,
London, W.C.1.

AUCTION SALE.

Wednesday next, October 26th, at eleven o'clock prompt.

Sussex Street Foundry, Lower Broughton, Manchester.

LOMAX, SONS & MILLS have received instructions to SELL BY AUCTION, on the PREMISES as above, the old-established

IRON FOUNDRY,

comprising the Freehold Land, Buildings, Motive Power, Plant, Machinery and Office Furniture, etc.

The LAND comprises 1,796 square yards, Freehold, subject to a Chief Rent of £14 10s. per annum.

The BUILDINGS contain a floor area of 1,570 square yards or thereabouts, and include Offices, Workrooms, Two Foundries, Core Stores, Core Making and Dressing Shops, Sheds, Stable and Large Yard. A portion is sub-let on a tenancy terminable by six months from any quarter day at a rental of £65 per annum.

The POWER and PLANT include 9- and 8-h.p. Motors, 440 volts; Shafting; Metal Hoist; "Roots" J size Blower; Two Cupolas; 4½-, 1½- and ½-ton Geared Ladles; Shank Ladles; 5-ton Electric Travelling Crane, 35-ft. span; 5-ton suspended Weighing Balance; Overhead Runways; 20- and 10-cwt. Triplex Lifting Blocks; Loam Moulding Mill; Dressing and Pulley Moulding Machines; 100 tons of Moulding Boxes and Weights; 90 pairs of pressed steel Flasks; all utensils; Office Furniture; New Stores; "Dey" Time Recorder; Copper Water Heater; Safes and Effects.

N.B.—The Property will in the first instance be offered as a WHOLE in one Lot, and if not so disposed of THE LAND and BUILDINGS will be offered together and THE PLANT sold PIECEMEAL as per catalogue.

For Catalogues or further particulars apply to the AUCTIONEERS, "Clarence Buildings," 2, Booth Street, Manchester (Tel. Central 3668), and Central Chambers, Bolton (Tel. 181); Messrs. LEACH, JOHNSON & COMPANY, Chartered Accountants, 3, Queen Street, Manchester; or to Messrs. WM. ALMOND & SONS, 17, Dickinson Street, Manchester.

MACHINERY.

MACHINERY PLANT, &c., FOR SALE.

Set of MOTOR-DRIVEN THREE-THROW HYDRAULIC PUMPS, 4½-in. rams, 15-in. stroke, driven by 250-h.p. 3-phase motor.

Set of TWO-THROW BELT-DRIVEN HYDRAULIC PUMPS, 1¾-in. rams, 4-in. stroke, by Hy. Berry.

One HYDRAULIC ACCUMULATOR, 8-in. dia. ram, 13-ft. cylinder, steel casing 9-ft. dia., by Hydraulic Eng. Co.

Nearly New HYDRAULIC INTENSIFIER, rams 17-in. x 9½-in. dia., 5-ft. stroke, hyd. pressure 1,500 lbs.

4-wheel 14-in. LOCOMOTIVE (Baldwin, 1917 make), 4-ft. 8½-in. gauge, 180 lbs. steam working pressure, steam and hand brakes.

4-6-0 type 9-in. LOCOMOTIVE (Baldwin, 1917 make), 2-ft. gauge, 175 lbs. steam working pressure.

Two LANCASHIRE BOILERS, 30 ft. x 8 ft., reinsure 110 lbs. pressure.

LANCASHIRE BOILER, 30 ft. x 8 ft., reinsure 100 lbs. pressure.

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD.

MACHINERY.—*Continued.*

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

One 30-cwt. Cupola, by Constructional Engineering Company, overall height 31 ft., dia. of shell outside 2 ft. 6 in.

Two Moulding Machines, by Tabor.

One ditto, Mumford.

One-ton geared Ladle.

J. Collis & Sons,
Sunbury Common, Middx.

FOR SALE, Denbigh Moulding Machine, No. 2 Marvel, perfect condition; also 15-cwt. Green Cupolette, complete direct-coupled motor.—Write offers, Box 468, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

One 12-ton Overhead Travelling Crane, hand operated, span 24 ft. 6 in., price £50.

One 20-cwt. Overhead Travelling Crane, hand operated, span 26 ft. 6 in., price £17 10s.

For further particulars write Box 476, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MISCELLANEOUS.

FOUNDRY BARROWS (New and Second-hand).

ALL STEEL BARROWS, 2 Wheels.

19 Barrows, holding 12 cwts. Flue Cinder.

16 Barrows, holding 17 cwts. Flue Cinder.

FOUNDRY SHOVELS:—

39—No. 8 Type.

23—No. 12 Type.

John Cashmore, Great Bridge, Staffs.

ADVERTISERS invite correspondence with suitable Ironfounders willing to undertake the manufacture of Domestic Hot Water Boilers at competitive prices.—Box 474, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—Cleghorn & Company, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

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PARTING POWDER.—Have you tried ours? Efficient and cheap.—Wm. Olsen, Ltd., Cogan Street, Hull.

MAUGHLIN PATTERN LETTERS AND FIGURES.—Die cast complete with pins in one piece, ready for fixing; no shellac required; simply drive them in and they will not come off; send for samples and prices.—A. Lakin & Son, Totley Rise, Sheffield.

'Phone: 287 SLOUGH.

TRY HAMMOND FIRST

NEW OIL SAND MIXER, latest type	£14
NEW ½ Ton LADLE (enclosed gear) ..	£14
NEW 1 Ton LADLE, "COLLIN" ..	£20
NEW 1½ Ton LADLE "COLLIN" ..	£24
NEW 2½ Ton LADLE "GREEN" ..	£28
3-ton "EVANS" LADLE, Good as New	£30
12 Ton "EVANS" LADLE, Good as new	£70
1 Ton DAVY STEEL CONVERTOR, with Motor and Tilting Gear ..	£120

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS.

BUY FROM ME AND SAVE MONEY.

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